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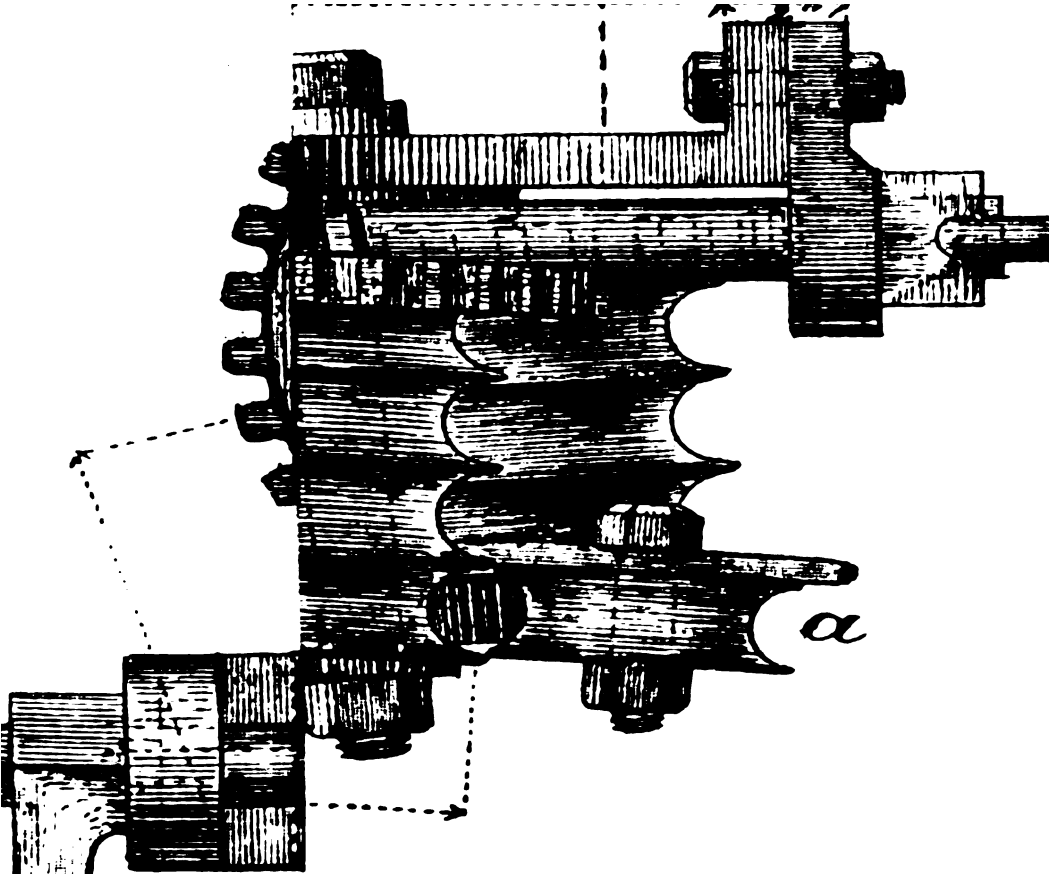
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III

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VI

OF

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ANNUAL REPORT

OF THE

CHIEF OF ENGINEERS,

UNITED STATES ARMY,

TO THE

SECRETARY OF WAR,

FOR

THE YEAR 1883.

IN THREE PARTS.

PART II.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1883.

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1884, June 16.

Gift of
The Chief of Engineers.

A P P E N D I X E S

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

APPENDIX O.

IMPROVEMENT OF SABINE PASS AND BLUE BUCK BAR, AND OF SABINE AND NECHES RIVERS, TEXAS.

**REPORT OF CAPTAIN WILLIAM H. HEUER, CORPS OF ENGINEERS, OFFICER
IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER
DOCUMENTS RELATING TO THE WORKS.**

IMPROVEMENTS.

- | | |
|--|-------------------------|
| 1. Sabine Pass and Blue Buck Bar, Texas. | 3. Neches River, Texas. |
| 2. Sabine River, Texas. | |
-

UNITED STATES ENGINEER OFFICE,
New Orleans, La., July 3, 1883.

GENERAL: I have the honor to forward herewith my annual reports of the river and harbor improvements under my charge for the fiscal year ending June 30, 1883.

Very respectfully, your obedient servant,

W. H. HEUER,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

O 1.

IMPROVEMENT OF SABINE PASS AND BLUE BUCK BAR, TEXAS.

For the purpose of securing deeper water over the bar at this place, a channel of 12 feet in depth and 75 feet in least width was dredged through it in 1878. This channel was not self-maintaining, and a second channel was afterwards dredged on about the same line as the first. This cut soon refilled. Experiment and observation showed that a dredged channel could not be maintained, except by constant dredging at a heavy expense. After a complete survey of the pass and a careful study of the currents, tides, and all physical data available, the question of obtaining a channel by the construction of jetties was considered. A report, project, and estimate of cost was made in 1882 by Captain Heuer, the engineer then in charge of the work. The project was referred to a Board of Engineers for Fortifications and River and Harbor Improvement for examination and report, all of which was transmitted to Congress March 28, 1882, and printed as House Ex. Doc. 147, Forty-seventh Congress, first session.

The proposed plan was estimated to cost over \$3,000,000. It contemplated the construction of two jetties, each nearly 4 miles in length, to concentrate and confine the water, and thus produce a scour sufficient to maintain a channel when once established.

On August 2, 1882, Congress appropriated \$150,000 for improving Sabine Pass and Blue Buck Bar, Texas. This amount, together with balances left from former appropriations, \$151,296, gave us about \$300,000 with which to commence the new project.

In September, 1882, proposals were invited by advertisement, and in October following the work was let by contract to the lowest responsible bidder to build about \$290,000 worth of jetty; the specifications giving all information necessary to bidders, and requiring them to state the price per cubic yard for brush mattresses, and of stone per ton, put in place in the work.

The contract was awarded to F. A. Hyatt & Co., of Texas, and as a work of this magnitude required a considerable plant, estimated to cost about \$50,000, they were given until January 1, 1883, as the time at which the work of actually building a part of the jetty was to commence, and their contract was to expire not later than December 1, 1883, or as much earlier as they could build \$290,000 worth of jetty.

The west jetty was commenced early in January, and though much time has since been lost in consequence of bad weather and numerous other delays, the progress thus far has been quite satisfactory, and has resulted in building the foundation of the west jetty from the shore continuously beyond the crest of the bar, a distance of 10,600 running feet, or a little over 2 miles in length, and varying in width from 15 to 60 feet, depending on the depth of water in which they are placed.

The mats within the jetty are in all respects identical with those now being constructed by Colonel Mansfield in his Galveston jetties. I am indebted to him for many suggestions and much valuable information. Where the water did not exceed 4 feet in depth, it became a question whether the jetty should consist of two vertical tiers of mats each 2 feet thick, or of one mat 4 feet thick. We adopted the single mat 4 feet high with the best of results. Since then, where not too much exposed to the action of the sea, we build thick mattresses in preference to thin ones as a matter of economy to the work. The brush-work costs us in place \$2.25 per cubic yard, the rock ballast costs us \$3.90 per gross ton of 2,240 pounds. We therefore use as little rock as possible, just sufficient to sink the mat in place, and then throw on a little extra weight for safety sake, to guard against loss in case of a sudden storm. We have been using an average of 1 ton of rock to 7 cubic yards of brush, while the proportion of 1 to 9 is generally sufficient to sink the mat. In a few days after a mat has been sunk it becomes filled with mud to such an extent that it is almost impossible to move it without breaking the mat to pieces. In one instance the contractors placed a mat in position during high tide; when the tide fell, it grounded; they had no rock ballast available to put on it; the weather looked favorable, and they concluded to let it remain where it was until the next day; during the night a severe storm came up with an unusually high tide; the storm lasted several days; the shore end of the mat had accumulated mud and stuck fast to the muddy bottom; the outer or sea end of the mat was afloat and was lifted and pounded by the sea, until about 30 feet of it was whipped to pieces; a little rock ballast was afterwards added to the sound part of the mat and such part was accepted; in a few days the brush was so full of mud that it was impossible to move the mat; two other unballasted mats afterwards drifted from the

line of the jetty and lodged in shoaler water; in a few days they had accumulated so much mud that it was impossible to move either of them. The remarkable behavior of these mats in the rapid accumulations of mud has led me to consider whether or not some much cheaper material than rock could be used to sink the mat in place and hold it there for a few days until the sediment should lodge in the brush and hold it there. The grillage at top and bottom of each mat forms a series of pockets each about 3 feet by 5 feet in size, by about 1 foot in depth, and I am anxious to try mud dredged from the channel as a ballasting material. If a mat be anchored over the position it is to occupy and these pockets be filled or partly filled with mud amply sufficient to sink it, there is good reason to believe it will remain in position forever. The only danger liable to happen is, that a storm may arise within less than a day after a mat has lodged, and may wash the mud from the pockets sufficiently to let the mat float away; but this seems improbable, and my impression is that much of the mud dumped into the pockets will work down into the brush and hold the mat in place until nature completes the work thus begun. We accept no mats until they have been in place in the jetty for forty-eight hours—and the contractor is so willing to take the risk on three or four mats loaded with mud, that I have ordered the experiment to be made. If the experiment succeeds we shall save hundreds of thousands of dollars in the final cost of the jetties; if it fails, we simply pay the cost of the hire of a dredge-boat for one day.

The quarries from which the rock ballast is obtained are about 100 miles from Sabine Pass, and the only means of transportation from there to the pass is by means of the railroad now in operation. It is reported that the railroad company are charging the contractor 2 cents per nett ton per mile for hauling this rock, or say \$2 per ton for transportation alone without loading or unloading the cars. As the rock has to be quarried, hauled to the cars, loaded, and finally unloaded, then be reloaded on barges, and finally put in position in the jetty, it is fair to infer that the contractor is losing money on the rock part of his contract. If we can find a substitute for rock ballast, it is fair to presume that the railroad company will come down to a reasonable rate for the transportation of rock.

On the bar and its seaward slope, the foundation mats of the jetty are built wedge-shaped, thin at one edge and thick at the other, the thin edge exposed to the sea, the thick edge toward the axis of the jetty. This shape offers a small resistance to the action of the sea and prevents a mat from being torn to pieces during a storm.

There is also a marked advantage in having a foundation mat thin and flexible, as in the event of a scour such mat easily conforms to the shape of the bottom, which a stiff or rigid mat could not do. The mats above the foundation course may be made stiffer, and it is possible that rafts of logs and brush combined with slabs may be used economically as the work progresses. A small amount of money has been withheld for experimental purposes, and if any cheaper construction than that now in use can be found, that will prove satisfactory, we shall be prepared to adopt it.

The jetty as far as built has as yet had no appreciable effect on the bar, nor was any beneficial effect expected; it is even questionable if, when this jetty is completed, we shall have any greatly increased depth of water on the bar. The project of last year contemplated that one jetty be completed before the second jetty was commenced. This is a perfectly safe plan to work upon, but will not in all probability give the deepest water in the shortest time. From the effect which only one

course (foundation) of mats has had in increasing the current and in changing its direction, and in causing such immense deposits between the jetty and the Texas shore, it is probable that if the second jetty was pushed along as the first jetty has been, that we should now have had an increased depth of water on the bar. The present contract only permits work on the west jetty. The money available will carry the foundation course out to perhaps a depth of 14 or 15 feet of water, with portions of the second tier of mattresses, where the currents cross the present line of jetty. When this contract is completed, which will probably be about December 1, 1883, such part as has been constructed will be reasonably secure against any damage; then, if Congress appropriates as much money as can be profitably expended in the next fiscal year, it might and probably would benefit commerce more to start the second jetty and carry it beyond the crest of the bar than it would to expend this money on the west jetty. It is probable that if both jetties were built out to 14 feet depth of water there would be a channel of at least 14 feet depth between them, and in such event it is more than probable that the lumber trade alone would send over this bar ten times the value of the commerce now crossing it.

Between January and July of this year there has been spent on jetty construction at Sabine Pass \$148,373.83, to show for which we have a little over 2 miles of jetty. It is fair to infer that the balance of available funds, \$152,922.23, can be expended advantageously by December 1, 1883, and we could use to advantage another \$150,000 by June 30, 1884, if we had it to spend.

It is clear, therefore, that \$300,000 can be profitably expended on one jetty in a year, and as the project requires two jetties, which could be built simultaneously if funds were available, it is probable that \$600,000 could profitably be expended on this work in a fiscal year.

It is certain that the jetties can be built for less than my estimates of 1882. My estimate was at the rate of \$3 per cubic yard. We are building under the present contract at about \$2.45 per cubic yard. The plant, consisting of tugs, steamboats, barges, mattress-ways, &c., for undertaking a work of this kind, costs about \$50,000, and as there are very few contractors who have such plant available, they cannot afford to bid on such work at a reasonable price, unless the contract is for a large amount, and they will all probably figure on the cost of the plant to come from the profits of the job.

The following is an abstract of the bids received for doing this work :

Abstract of proposals for improving harbor at Sabine Pass, Texas, received at noon, October 21, 1882.

No.	Names and residences of bidders.	Brush mattress, in place.	Rock ballast, in place.
		<i>Per cubic yard.</i>	<i>Per ton of 2,240 lbs.</i>
1	A. M. Shannon & Co., Galveston, Tex	\$2 44	\$4 00
2	F. A. Hyatt & Co., Beaumont, Tex	2 25	3 90
3	J. W. Dennis, Buffalo, N. Y.	2 65	5 50
4	League & Jones, Galveston, Tex	2 25	4 47
5	Rittenhouse Moore, Mobile, Ala	2 70	4 50
6	A. M. Newton & J. H. Eckstein, New York City	2 29	4 45
7	Wright Schaumburg, New Orleans, La	2 47	3 97
8	John Maguire, Mobile, Ala	2 49	5 75
9	S. N. Kimball, Mobile, Ala	3 33½	5 83½

Awarded to F. A. Hyatt & Co., at \$2.25 and \$3.90.

Messrs. Hyatt & Co.'s contract will probably be completed December 1, 1883. This will exhaust the money available, except a small amount

withheld for office expenses and experimental purposes; the work will then have to remain in this condition until another appropriation becomes available. With large appropriations favorable contracts can be made. If only a small appropriation be made, it might be desirable to advertise for proposals under it. Should the bids be unfavorable, they can be rejected, and the amount appropriated be held until further appropriations be made.

The work is situated in the collection district of Galveston, Tex., but has a deputy collector stationed at Sabine Pass who has kindly furnished the statistics appended to this report.

My thanks are due to Mr. T. L. Raymond, the assistant engineer in local charge of the work, for strict attention, hard work, and conscientious devotion to his numerous duties.

Money statement.

July 1, 1882, amount available	\$151,296 06
Amount appropriated by act passed August 2, 1882.....	150,000 00
	<hr/> 301,296 06
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$133,960 47
July 1, 1883, outstanding liabilities.....	14,413 36
	<hr/> 148,373 83
July 1, 1883, amount available (under contract).....	152,922 23
	<hr/> 600,000 00

REPORT OF MR. THOMAS L. RAYMOND, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE, Sabine Pass, Texas, July 7, 1883.

SIR: I have the honor to submit the following report upon the improvement of Sabine Pass, Texas, for the year ending June 30, 1883:

In accordance with your instructions, I reached this place November 27, 1882, and began preparations for staking out the line of the proposed work as laid out in your report to the Chief of Engineers, dated March 28, 1882, recommending the construction of such part of the west jetty as the available funds would permit.

Upon December 5, 1882, Messrs. Hyatt & Junker, the contractors for the work, arrived at Sabine Pass, but it was not until the 19th of the same month that work was begun.

The interval was employed by me in erecting stations from which to locate the work, establishing bench-marks with reference to the planes of mean low and mean high tides, and in staking out a portion of the line of the jetty.

In our survey of the entrance to the pass of November and December, 1881, triangulation stations were established at necessary intervals along both shores of the pass, and the centers of these being found undisturbed, have been used in locating the work.

The plane of mean low tide as established by Assistant Engineer H. C. Riply in 1876, by comparison with the Galveston gauge and checked by six months' tidal records during 1881, was transferred to a point near the shore end of the jetty by levels from the bench-mark at the life-saving station down the Texas shore.

The line of the west jetty, as laid out by you and shown on the accompanying chart, begins at the high-water line of the Texas bank of the pass at a point 4,800 feet above its mouth, as defined by Texas Point, and opposite the termination of the 13-foot contour. From this point, by a circular curve 7,500 feet long, as measured upon 500-foot chords, with a radius of 8,750 feet, the crest of the bar is reached at a distance of 50-foot to the eastward of the wreck of the *Clifton*, and thence by a tangent to this arc the line runs 15° east of south to the 20-foot contour. The whole line follows approximately the direction of the channel dredged by the *Essayons*, at one point approaching within 200 feet of the narrow cut, which is all that remains of that channel.

PLANT.

As soon as land facilities could be obtained the construction of the mattress wharf and ways and quarters for the men were begun. The site selected is about $2\frac{1}{2}$ miles above the shore end of the jetty on the Louisiana bank of the pass, at a point where a 7-foot channel approaches the shore. Although so far removed from the work, this location has the advantage of complete protection from storms, and mattresses after launching are in no danger from destruction by heavy seas, and are, moreover, not subject to the severe strains of the strong currents which pass through the channel on the Texas side. The constructions of these works are shown in front and side elevations on the accompanying tracing. The upper ways are 310 feet long, and were, as shown in the drawing, 30 feet wide, but 100 feet of them have been increased to 45 feet in width recently. They have an inclination of 1 to 7 $\frac{1}{2}$, the lower edge being 5 feet above mean low tide.

The lower ways are 210 feet long and 45 feet wide, with an inclination of 1 to 7, the lower edge being 3 feet above mean low tide.

As shown in the drawing, these ways consist of inclined tables, upon which are spiked in the direction of the slope 2 by 4 inch pieces, spaced 5 feet apart, which is the distance between the cross-fascines in the mattress; upon these pieces are tacked half-round strips to diminish the friction in launching. In the table and along these pieces, holes are bored 3 feet apart, the distance between the longitudinal fascines in the mattress; these holes are for the stakes supporting the ropes used in binding the upper and lower grillage together.

Behind the ways and running their entire length is a platform 8 feet wide for storing the completed fascines until needed.

The wharf, which is between the upper and lower ways, is 100 feet long by 49 feet wide, and upon it are the fascine racks, three of which are 100 feet and one 90 feet long.

Stone runs.—There was some delay in securing a side-track to the bank of the pass to facilitate the transfer of the stone from the cars to the barge, and it was not until February 10 that this spur was completed with the runs from the track to the water's edge.

These runs consist merely of inclined gangways supported upon trestles and piling, extending from the track to the bank, a distance of 130 feet, down which the stone brought by rail is wheeled from the cars directly to the barge. They are on the Texas bank of the pass, about $2\frac{1}{2}$ miles above the shore end of the jetty.

Floating plant.—The floating plant consisted until May of the following:

One tug-boat, 65 feet long, used in towing sinking-barge and mattress to the work.

One stern-wheel steamboat, for towing brush-barges and transporting material from the Neches and Sabine rivers to Sabine Pass.

One sinking-barge, 100 by 27 $\frac{1}{2}$ feet, capacity 200 tons on a draught of 4 $\frac{1}{2}$ feet.

Three large ship-yawls, for running and lifting sinking-barge anchors.

Three barges for carrying brush, capacity 200 to 350 cords.

In May were added a larger tug-boat and a small brush-barge.

In June the iron tug Fowler, 75 feet long, was purchased, and the two chartered tugs were dispensed with, while another large brush-barge, making five in all, was added. At intervals, when found expedient, other steamboats have been engaged temporarily to assist in transporting brush.

MATTRESSES.

The mattresses sunk have been usually 100 feet long, and the widths have varied from 15 to 45 feet, while the thickness of the brush filling has been from 1 to 5 $\frac{1}{2}$ feet. They have been made in accordance with the specifications of the contract, which describe them as "consisting in general terms of two or more layers of brush-bundles, compressed and securely bound between grillages of brush or cane fascine ropes." The fascine ropes "average about 6 inches in diameter, choked and securely bound by a single strand of spun yarn, or its equivalent, every 8 inches of its length, thus forming long flexible ropes or cables." The grillage is formed by placing the fascine ropes in two courses at right angles to each other. The fascine ropes in the longitudinal course are spaced 3 feet apart, and in the cross-course 4 to 5 feet apart, and at the crossing are securely lashed with marline or spun yarn where not otherwise lashed.

The filling, the alternate layers of which are laid at right angles to each other, "is compressed and bound between the grillages by 18-thread ratline at each crossing of the fascine ropes around the edges of the mattress and at every alternate crossing, throughout the body of the mattress."

In building a mattress, the fascine ropes for the lower grillage having been cut in lengths to suit the dimensions of the mattress, are laid against the stakes previously set in the ways. The ratline is then passed around the proper crossings and the free end attached to the top of the stakes.

The brush barge is then moored alongside and the filling of brush built up between the stakes with brush passed directly from the barge on which it was transported to the work. When the proper height has been reached the top grillage is laid on and the mattress is "tied down" with all the compression the ratline will bear, the rope passing around the crossing in the top grillage directly over those to which it is attached in the bottom. The stakes are now taken out and the mattress launched, usually with little difficulty, by blocks and tackle at both ends, and then moored to piling to await a favorable time for sinking.

METHODS OF SINKING MATTRESSES.

Owing to the shoalness of the water for a distance of 1,100 feet from shore, it was found necessary to build the first eleven mattresses in place. On January 1 work was begun by the construction of the outermost of these. A barge loaded with brush was floated in-shore along the line of the jetty until it was grounded, and the lower grillage was laid out upon the water beside it, the stakes being driven into the bottom. Brush was then passed to the men standing in the water, and the mattress built to the proper height as it gradually sunk to the bottom. The top fascines were then laid on and the mattress tied down. In this manner the work was carried to the shore.

Although no stone had yet been received, the contractors decided to take the risks, trusting to the shoalness of the water to protect these unballasted mattresses from injury. In the interval, however, between the time of completion of the mattresses and the arrival of the stone, several severe storms carried away two mattresses to a distance of 500 feet from the jetty and they had to be replaced by new ones; two others were so far removed out of line that they had to be rebuilt, and the end of another was destroyed; two others were moved slightly out of position, but not enough to interrupt the continuity of the work.

As soon as stone was received, light barges were loaded, floated alongside this shore work on high tide, and the whole properly ballasted, since which time they have remained uninjured. It was not until February 11, 1883, that the first car-load of stone was received, and by the 20th of the same month the entire shoal-water work was completed, and the first mattress built upon the ways was towed to position and sunk. The difficulty of this work was greatly increased by the severity of the weather during January and February, the workmen being obliged to labor in the water most of the time on a bottom so soft as to afford very insecure footing.

Beyond Station 11 (Stations being 100 feet apart and numbered from shore out) the depth of water permitted the floating of mattresses into position which had been constructed upon the ways.

The work of sinking them is accomplished by the use of the *sinking-barge*. This barge is fitted up with five stages projecting from the starboard side 20 feet apart and 30 feet long, guyed to masts stepped 3 feet back from the side. There are three windlasses at the bow and three at the stern. This barge, loaded with stone, is towed as near the end of the work previously done as may be, and by means of anchors running in necessary directions is hauled directly alongside the position of the next mattress to be sunk. During this time the mattresses are towed down, usually three at once, and anchored near the barge. The one to be sunk first is then detached from the others, swung in against the barge, and secured to it by "sinking lines" hanging from the stages. There are two lines from each of the five stages, which, besides holding the mattress against the barge, serve also to support it above water while the stone is being distributed over it. The stages from which the mattress thus hangs projecting over the greater part of it, facilitate the proper distribution of the ballast.

Until loaded sufficiently to sink rapidly, the mattress is kept in exact position by heaving on the lines running to anchors in all directions. When the proper amount of stone has been thrown, the sinking lines are let go at once and the mattress sinks to the bottom. More stone is then added until the total amount reaches the proportion of 1 ton to 7 cubic yards of brush, and the barge is then moved into proper position for the next mattress. The amount of stone necessary to sink a mattress varies considerably with the character of the brush, and the length of time the mattress has been in the water, but usually 1 ton of stone to 9 cubic yards of brush will sink a new mattress built of pine brush.

The greatest number of mattresses sunk in a single day was five, and this has been done frequently.

The greatest amount of material placed in the work in a single day was 2,034.6 cubic yards of brush weighted with 279 tons of stone.

The largest mattress sunk contained 530 cubic yards of brush.

GENERAL PLAN.

The controlling idea in the prosecution of this work has been to raise the west jetty to as great a height as possible with the available funds consistent with the perma-

nence of this and future work while carrying the foundation course sufficiently prevent scouring beyond it on the projected line where mattresses may be sunk after.

Upon the accompanying chart are shown the position and dimensions of a mattresses sunk to June 30, 1883, in plan. The longitudinal section shows the h of the jetty along its central line, together with the amount of work done during month, while the cross-section gives an idea of the form of the mattresses wher jetty is 60 feet wide. The cross-section, where the width is 45 feet, is of the same 1 but obtains the width with a single mattress.

In accordance with your instructions, the width of the foundation has been pr tioned to the depth of water and the consequent height of the completed jetty, al ing for side slopes of 1 on 2, and a foundation berme on both sides of 15 feet.

From shore to a depth of 4 feet at mean low tide the jetty was built at once u mean high tide over a length of 1,400 feet, the width being 15 feet for the first 1 feet, and gradually increasing to 30 feet width. Over the next 700 feet to Station the width was increased to 45 feet, with a view to another course to complete height. With these mattresses and all since put in, a change was made in the f of the mattress; previously the mattresses were built with the top and bottom 1, allel, and the change consisted in building them so as to form a slope from the cen line of the jetty to either side, thus economizing material, obtaining greater hel with the pliability desirable on the edges, and avoiding the direct force of the against the side of the mattress. Where the width of the jetty foundation is 45 f the single row of mattresses which complete this width are built highest in the cent sloping to either side. Where the width of 60 feet requires a double row of mattre they are built as shown in the cross-section on the chart, sloping from one edge tially across the mattress and sunk with the thick edges abutting on the central l of the jetty.

From Station 21 to Station 55 + 50, a distance of 3,450 feet, in crossing what is kno as Texas Channel, the width was increased to 60 feet to allow for three tiers in t completed work.

From Station 55 + 50 to Station 87, a distance of 3,150 feet, the width was reduc to 45 feet in crossing the shoalest water of the bar.

The remainder of the work, which on June 30 was at Station 106, is 60 feet wide

In that portion of the work where a double row of mattresses is used the ends those in one row project beyond those in the other, breaking the joints across t jetty.

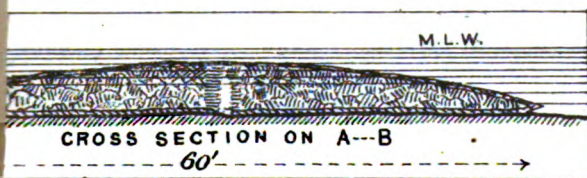
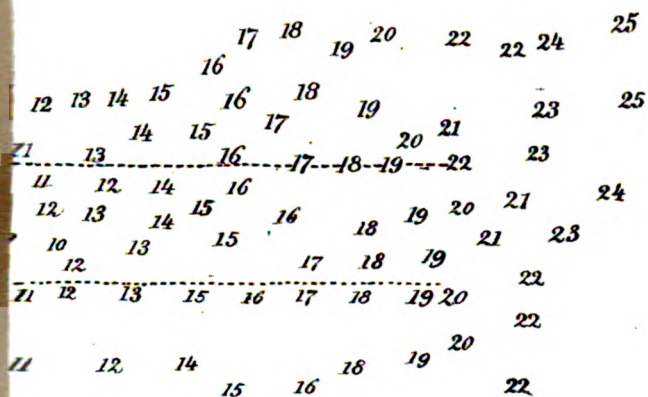
The following table gives the number of days in each month when the weather p mitted sinking, the number of mattresses sunk, the length of foundation course built, number of cubic yards of brush, and tons of stone used:

Month.	Number of sinking days.	Number of mattresses sunk.	Length of foundation course built.	Brush used.	Stone used.
1883.					
February.....	14	13	1,200	1,717.5	249
March.....	21	31	2,010	10,924.4	1,696
April.....	14	44	2,244	12,776.4	1,765
May.....	11	31	2,946	14,556.9	1,994
June.....	19	40	2,200	11,246.5	1,631
Total.....	79	159	10,600	51,221.7	7,406

Average number of men employed, 70.

RESULTS.

The work having been recently begun, and, as compared with the full project having been carried to so limited an extent on only one of the two jetties contemplated, no extensive examinations have been made to determine the effect produced thus far. A careful examination made, however, in June, along the line of the jetty, the results of which are shown in the chart, reveals the fact of a decided fill behind the jetties. The height of this deposit back of the older portion of the work averages 2 feet, and has reduced the depth of water there to such an extent as to afford considerable protection to the work from the sea on the west side. The mud forming this deposit has been carried during heavy blows into the still water produced by the works and there dropped; there is every reason to believe that much of this mud has been deposited in the mattresses along the whole line, those left bare at low tide showing this to be the case with them, and the height of the deposit on the west side against the jetty indicating the same.



With annual report
June 30th 1883
(Signed) W. H. Stever
Capt. Engrs.



While the current has been sensibly deflected along the line of the work, it was considered too early to expect any improvement in depth on the east side, and none has been observed.

The longitudinal section and profile along the central line of the jetty shown upon the chart exhibits the present depth of water over the work and to the westward of it, together with the depth along the line before the mattresses were sunk, which is the same as that now existing 20 feet east of the jetty.

From a comparison of present depths on the jetty with those observed when the mattresses were first sunk there seems to have been but little settlement after the bottom fascines were imbedded in the mud. The condition of the work on June 30, 1883, was satisfactory, only three mattresses having been injured, and they not sufficiently to impair their efficiency. The only danger to which the work seems subject is the tearing up of the top by the sea when near the surface of the water. The mattresses which have suffered thus far were at the end of the work during storms, and were injured by the sea breaking against the perpendicular end. No loss has yet been sustained by the Government from damage to the work.

The courtesy of Mr. G. C. Arledge, deputy collector of customs, has supplied the accompanying statement of the domestic imports and exports.

Very respectfully, your obedient servant,

THOS. L. RAYMOND,
Assistant Engineer.

Capt. W. H. HEUER,
Corps of Engineers, U. S. A.

Statement showing amount of domestic imports and exports of the port of Sabine, Tex., for the fiscal year ending June 30, 1883.

Date.	Assessed mer- chandise.	Lumber and shingles.	Cotton.		Sheep.		Hides.		Coal.	
			Bales.	Value.	No.	Value.	No.	Value.	Tons.	Value.
1882.										
July	\$4,000	\$2,910								
August	7,000	3,015								
September	4,750	2,780								
October	7,000	2,156	28	\$1,400						
November	5,000	612								
December	3,500	1,320	5	250	500	\$1,250				
1883.										
January	7,075	1,650	13	650			100	\$300		
February	7,250	1,542								
March	4,750	2,610							50	\$500
April	4,500	2,130								
May	3,125	1,470							50	500
June	3,250	2,112							350	2,900
Total	61,200	26,306	46	2,300	500	1,250	100	300	450	3,900

Grand total, \$95,255.

Vessels passing through from mills on Sabine and Neches rivers without stopping would probably augment this statement about double. Lumber is now being brought down the Sabine and East Texas Railroad for shipment to New York. In all probability business will increase very rapidly.

Very respectfully, &c.,

G. C. ARLEDGE,
Deputy Collector of Customs.

W. H. HEUER,
Capt. of Engineers, U. S. A.

O 2.

IMPROVEMENT OF SABINE RIVER, TEXAS.

The original depth of water before improvement on the bar at the mouth of the river was $3\frac{1}{2}$ feet.

The project made for the improvement in 1871, modified in 1873, was

to increase the depth of water over the bar so as to admit vessels drawing 5 feet, and to remove logs and snags, and make cut-offs to accommodate the commerce of the region on and near the river.

The following are the appropriations thus far made :

June 3, 1878.....	\$10,000
March 3, 1879.....	6,000
June 14, 1880.....	5,000
March 3, 1881.....	7,000
August 2, 1882.....	4,000
Total.....	32,000

Of the amount thus appropriated \$27,453.43 has been spent in dredging a channel at the mouth having a 6-foot depth and a width of from 70 to 100 feet, making several cut-offs in the Narrows and river, and cutting off or removing logs, snags, and dangerous trees on the banks. This has enabled vessels to get up to Belgrade with comparative safety when the river has a navigable stage of water. At present it is not thought that a deeply laden skiff could get to Belgrade.

During high-water stages steamboats make a few trips to East Hamilton to bring down cotton; 1,800 bales were brought down in 1878. As the river rises 25 feet in a flood there is no trouble to get to East Hamilton during such stage except that due to a rapid current and the immense quantities of logs, snags, &c., floating down. The river is principally used to float down logs as far as Orange, Tex., where there are numerous fine saw-mills.

In 1881 the bar at the mouth of the river had again shoaled up, and during the present fiscal year a fine channel 6 feet deep and 100 feet in width was redredged for a length of 5,600 feet. It is thought that this will answer all the requirements of commerce for several years to come.

Attention is respectfully invited to the fact, as shown in the sketch appended, that at about 2 miles below the town of Orange the river makes a bend over 2 miles in length; the river almost makes a loop, the shortest distance across the bend being only 400 feet.

Some years ago a cut was made across this bend known as Ford's Cut-off; this is now used entirely by all vessels navigating the river, and all vessels using the cut-off are obliged to pay a toll; for steamboats it is said this toll amounts to \$3.50 per trip. At the foot of the bend, but in plain sight of the cut-off, a log-boom has been thrown completely across the river, thus obstructing all communication by the bend and necessarily compelling vessels to use the cut-off. This would be unobjectionable were the cut-off free of tolls, but at present it seems and is an imposition.

Above and below the town of Orange the mills throw out log-booms to hold the logs; in some cases these booms extend out to the middle of the river and even beyond, where they happen to be nearly opposite to each other; they are serious obstructions to navigation, and steamboats are sometimes several hours in working their way through these logs.

The river now is in as good a condition, so far as improvement is concerned, as it can be made, and is likely to remain so for several years. Occasionally the bar at the mouth will require dredging, and logs and snags may lodge in the channel in the Narrows and above and require removal, but the money available, \$4,546.57, is probably sufficient for this purpose.

No appropriation is asked for the year ending June 30, 1885.

The work is not susceptible of permanent improvement.



ORIGINAL ESTIMATES.

Work at mouth (report of 1871)	\$38,000
Removing snags, &c. (report of 1873)	18,000
Work on the Narrows (report of 1880)	17,500

This work is all done as far as it well can be, and is sufficient for the immediate requirements of commerce. In a few years more further appropriations may be required to again deepen the mouth, remove logs, &c.

The work is in the collection district of Galveston, Tex.; the nearest light-house is at Sabine Pass.

COMMERCIAL STATISTICS.

There has been no increase in commerce in consequence of the improvement. The principal use of the river is to float logs to the mills at Orange; thence they are sawed into lumber and distributed by rail.

Money statement.

July 1, 1882, amount available	\$11,805 09
Amount appropriated by act passed August 2, 1882	4,000 00
	<hr/>
	15,805 09
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	11,258 52
	<hr/>
July 1, 1883, amount available	4,546 57

O 3.

IMPROVEMENT OF NECHES RIVER, TEXAS.

This river was surveyed in 1872-'73 and resurveyed in 1880 from Bevilspport to its mouth.

When the improvement was commenced the bar at its mouth had but 2½ feet depth of water on it. A channel of 5 feet in depth and varying from 30 to 60 feet in width was dredged over the bar. Overhanging trees, logs, snags, &c., were removed in 1882 between Yellow Bluff and Bevilspport with a view to improve the high-water navigation of the river.

During the low-water season steamboats only run to Weiss's Bluff.

It is not thought that the high-water navigation of this river can be further improved, except by occasionally removing such logs, snags, &c., as may occasionally lodge in the channel. The only obstacle to low-water navigation as far as Weiss's Bluff is the shallow water at the bar at the mouth of the river. The channel here has again shoaled up as well as narrowed until only 3½ feet of water can be carried over it. The bar is about 2 miles in length and needs redredging about once in three years. The last work done on the bar was in 1880.

On August 2, 1882, Congress appropriated \$5,000 for continuing improvement of this river. This amount is insufficient to produce a good channel at the mouth, and as this is the only place on the river really requiring improvement, it is thought best to hold this money until a further appropriation is made, then to cut a good channel, say 100 feet in width and having 5 feet depth of water in it. This will require the removal of about 40,000 cubic yards of material; this at 30 cents per yard will cost about \$12,000; as we have \$5,156.85 left over from former appropriations, we shall need to complete the work indicated, say \$7,000.

The amount of commerce on the river has not increased any since the improvement commenced. The Sabine and East Texas Railroad is now in operation close to the Neches River, and affords an outlet for such freights as may offer. The great use of the river above Weiss's Bluff is to float logs to the saw-mills on the river. When the Sabine Pass improvement, now in progress, is completed, then it is thought that business on the river will increase greatly, as the lumber business will then have an open outlet.

The following are the appropriations thus far made for improving this river:

June 3, 1878	\$8,000
March 3, 1879	5,000
June 14, 1880	5,000
March 3, 1881	3,000
August 2, 1882	5,000
Total	26,000

The original estimated cost of the river improvement was :

Dredging channel at mouth (1874)	\$26,318 05
Removing snags, logs, &c. (1880)	15,000 00
Total	41,318 05

Of the above amount \$20,843.15 has thus far been used in improving the river, leaving a balance yet available from former appropriations of \$5,156.85 to continue improvement.

If an additional amount of \$7,000 be appropriated, it is thought this will be sufficient to make a good channel at the mouth, and satisfy the demands of commerce for several years to come. The work is not susceptible of permanent improvement.

It is located in the collection district of Galveston, Tex. The nearest light-house is at Sabine Pass.

COMMERCIAL STATISTICS.

It has been estimated that 10,000 bales of cotton could be raised on the river. How much is raised is not known. In 1880 it is said 3,000 bales were raised, but only a small portion found an outlet via the river. The river is principally used to float logs down to Beaumont, where they are sawed, and the lumber is then shipped by rail generally to Houston, Tex., and thence distributed.

Money statement.

July 1, 1882, amount available	\$281 44
Amount appropriated by act passed August 2, 1882	5,000 00
	5,281 44
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	124 59
July 1, 1883, amount available	5,156 85
Amount (estimated) required for completion of existing project	*12,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	12,000 00

*About \$12,000 will complete existing project, i. e., dredging mouth of river. Thereafter occasional small amounts will be necessary to remove obstructions as they occur.

APPENDIX P.

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATE OF TEXAS.

REPORT OF MAJOR S. M. MANSFIELD, CORPS OF ENGINEERS, BVT. LIEUT. COL., U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|--|--|
| 1. Entrance to Galveston Harbor, Texas. | 6. Pass Cavallo Inlet to Matagorda Bay, Texas. |
| 2. Ship-channel in Galveston Bay, Texas. | 7. Aransas Pass and Bay, up to Rockport and Corpus Christi, Texas. |
| 3. Trinity River, Texas. | 8. Harbor at Brazos Santiago, Texas. |
| 4. Buffalo Bayou, Texas. | 9. Protection of river bank at Fort Brown, Texas. |
| 5. Channel over the bar at mouth of Brazos River, Texas. | |

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 31, 1883.

GENERAL: I have the honor to forward herewith my annual reports relating to the river and harbor improvements under my charge for the year ending June 30, 1883.

Very respectfully, your obedient servant,

S. M. MANSFIELD,
Major of Engineers,
Bvt. Lieut. Col., U. S. A.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

P I.

IMPROVEMENT OF ENTRANCE TO GALVESTON HARBOR, TEXAS.

Estimate for north and south jetties, 1880.....	\$1,825,813
Appropriated 1880-'82.....	825,000
	<hr/>
	1,000,813

On the 30th of June, 1882, the work for the improvement of this entrance under the approved project of 1880 was in good condition. It consisted of—

1. *North jetty.*—A "trial section" of mattress work, with concrete ballast, 90 feet long, 60 feet wide, and 2½ feet high above the sand bottom, placed in June, 1880, at the outer end of the Bolivar gabionnade.

2. *South jetty.*—Mattress work with stone ballast, placed in 1880-'81-'82, extending from the end of the pile breakwater at Fort Point

out into the Gulf of Mexico, the total distance of the extreme ends of the jetty apart measured along the axis being 22,551 feet, with a gap of 1,774 feet, making the total length of the jetty 20,777 feet. Of this—

1,270 feet was 30 feet wide.
7,740 feet was 60 feet wide.
7,550 feet was 90 feet wide.
4,217 feet was 120 feet wide.

The length of the second course was 10,130 feet, of which—

290 feet was 30 feet wide.
9,480 feet was 15 feet wide.
360 feet was 10 feet wide (stone only).

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1883.

The work was carried on by hired labor with aid of plant owned by the Government, and by purchase of brush, cane, cordage, stone, and other materials, incidental and necessary, in open market, or by contract when time permitted for advertising in the usual way.

The entire work of the year consisted in extending the foundation course of the south jetty to a full width of 120 feet when thought necessary; raising up the jetty to a higher level by the addition of a second, third, and fourth course of mattress along its length; the closing of the gap near shore-line and the riprapping of the work by extra ballast to secure it at points so requiring; also, the building of sand fences at Fort Point to protect the channel over inner bar from drifting sand.

The contracts in force at the close of the last fiscal year have been completed in a most satisfactory manner.

1. *H. Marwitz & Co.*—Delivered 14,202 pounds spun yarn, 3,557 pounds sisal rope, and 700 pounds iron thimbles, at a total cost of \$1,631.10.

2. *Adolf Flake & Co.*—Delivered 15,571 pounds, 18-thread ratline, at a cost of \$1,537.63. (This contract was virtually closed June 7, 1882, but not so reported in last report.)

3. *Gulf, Colorado and Santa Fé Railway Company.*—Delivered 10,000 tons of stone (2,240 pounds to the ton), at a cost of \$32,500.

4. *Burnett & Ross.*—Delivered 145.02 cords of cane, at a cost of \$848.37. (Closed contract before completion of same; order of the honorable Secretary of War, November 4, 1882.)

5. *A. M. Shannon & Co.*—Delivered 5,500 cords of bush, at a cost of \$18,975.

6. *Isaac Heffron.*—Handled (transferred to barges) 10,110.02 tons of stone, at a cost of \$1,920.90.

After the closing of the contracts with Messrs. A. M. Shannon & Co. for brush, and Messrs. Adolf Flake & Co. for cordage, authority (approving project of July 14, 1882) was given for the purchase in open market of whatever materials were necessary to a proper prosecution of the work until such time as contracts under the new appropriation could be perfected. Under this authority Messrs. A. M. Shannon & Co. delivered 7,390.49 cords of brush (\$28,337.90), and Messrs. Adolf Flake & Co. delivered a quantity of cordage, &c., covering 651 pounds iron thimbles, 13,194 pounds spun yarn, 28,253 pounds ratline, and 3,244 pounds 3-inch sisal rope (\$4,375.75).

Under the appropriation of \$300,000, passed August 2, 1882, contracts were entered into with the following-named parties:

1. *Gulf, Colorado and Santa Fé Railway Company.*—For furnishing stone. Contract began October 15, 1882, and was completed March 31, 1883, by the delivery of 15,835.22 tons, at a cost of \$63,340.88.

2. *A. M. Shannon & Co.*—For furnishing brush. Contract began December 1, 1882, and was completed June 30, 1883, by the delivery of 15,000 cords, at a cost of \$59,250.

3. *Adolf Flake & Co.*—For furnishing ratline. Contract began October 14, 1882, and was completed February 28, 1883, by the delivery of 76,722 pounds, at a cost of \$8,055.80.

4. *H. Marwitz & Co.*—For furnishing cordage. Contract began October 11, 1882, and was completed January 31, 1883, by the delivery of 40,620 pounds of spun yarn, 6,225 pounds 3-inch sisal rope, 7,434 pounds 3, 4½, 4 inch manila rope, and 2,918 pounds 2½-inch iron thimbles, at a cost of \$6,125.47.

5. *Isaac Heffron.*—For handling stone—loading barges. Contract began October 5, 1882, and was completed March 31, 1883; 15,835.22 tons were transferred and loaded on barges, at a cost of \$5,463.16.

The authority still existing, the Gulf, Colorado and Santa Fé Railway Company, and Mr. Heffron, were, after the settlement of their contracts, permitted to continue the delivery of stone, and handling of same, at contract rates. From the 1st of April to the 31st of May, 1883, there were delivered and handled 3,612.2 tons, at a cost of \$15,695.

No very serious impediment was met with during the year to delay good progress of the work. Fair weather materially assisted the work in July, August, September, November, and December, 1882, and, excepting April, the later part of the fiscal year was not unfavorable.

On the 12th of October a sudden squall tore eight mattresses, four 30 feet by 90 feet and four 30 feet by 45 feet, from their mooring chain. Six of these mattresses became a total loss; two, one 30 feet by 90 feet and one 30 feet by 45 feet, were recovered and used in the work.

During the unusual low stage of water on the 29th and 30th of November the crest of the completed portion of the outer end of the jetty (approximately 3,225 feet in length) appeared above the surface, and thus enabled us to make a careful examination of it. Its appearance as presented was most satisfactory. The brush work was entirely covered with stone, and the stone was well bedded, and the older portion in place some time showed the stone strongly cemented together by accretion of shell and sea-weed or moss.

Again, in January 9 and 10, just succeeding in heavy "norther," the water was so low as to expose to view a large portion of the jetty. A personal examination of the entire line of work was made in a yawl-boat. This examination proved the condition of the work throughout as most satisfactory. The crest of the shore end was some feet above the water surface, and this for some distance out beyond the turn around the light-house. Beyond the gap we walked dry upon the jetty for several hundred feet; and beyond, over the shoal, the crest of the work was at the water surface. This portion had then been in place a year and a half, and exposed ends of oak stakes and pieces of brush here showed that the worm had done no injury. The outer 4,000 feet of the jetty was in admirable shape, except at two or three places along its crest (which was a foot out of water), when heavy seas had had some effect upon it. The damage was slight and was made good a few days thereafter by the deposit of a suitable amount of stone. As reported in my monthly report for January, I venture to state that the stability of the work was, by this examination, well proven.

The following correspondence is strongly illustrative of the great interest that the people of Galveston have in the improvement of their harbor entrance. In addition, it conveys valuable evidence of the worth of the improvement made here in the last three years, and it is with

much pleasure that I submit the correspondence which contains such strong testimony and guarantee of perfect confidence.

This correspondence is given in the order following:

1. Letter of March 9, 1883, from Mr. R. L. Fulton, mayor-elect, city of Galveston.
2. Letter of March 10, 1883, to Mr. R. L. Fulton, mayor-elect, in reply to letter of March 9.
3. Letter of January 29, 1883, from Irvine & Beissner and Adone & Lobit.
4. Letter of January 29, 1883, from Capt. J. N. Sawyer, agent of the Mallory Steamship Line.
5. Letter of January 30, 1883, from Committee on Harbor, Galveston Cotton Exchange, by the chairman, Mr. J. H. Metcalf.

LETTER OF HON. R. L. FULTON, MAYOR-ELECT OF GALVESTON, TEXAS.

GALVESTON, TEX., March 9, 1883.

DEAR SIR: Having been elected by the good people of Galveston to fill the important position of mayor, I address you now, even before I go into office, upon a subject very dear to me as well as to all citizens of Galveston.

I learn with much regret that what was known as the river and harbor bill failed to pass at the last session of Congress, and the common apprehension is that therefore you will be without sufficient means to carry on the work now under your charge, and in the progress and success of which the people of Galveston and of the whole State of Texas are so vitally concerned. In order to obtain such information as seems to me most important to be understood by the public authorities and by the people of this city, I respectfully request that you furnish me information upon the following points:

How long will you be able to continue your work with what money you have on hand, and in what condition will it be in case you have to suspend for want of funds? A clear statement on this point is especially invoked.

If you rely entirely upon an appropriation from the General Government, how long will it probably be before you can again commence work?

What is the last amount of money, aside from what you have on hand, that you will require to continue the work during the summer, and with that additional amount furnished what will be the probable difference in depth of water on the bar for the next season's business compared with what we now have, or will have, at the time you will have to stop work when the Government funds are expended?

I shall be glad to have you express yourself freely and fully, as your opinions will have great influence with our citizens, and form a basis on which intelligent and useful action on the part of the city of Galveston might be secured.

I need not say how largely this city is interested in deep water on the entrance to Galveston Harbor; and not more so than are the States west of the great Mississippi River.

In the position to which I am elected I can have no greater duty than to endeavor to promote it by all proper means within the scope of my official authority.

I am, sir, most respectfully, your obedient servant,

R. L. FULTON,
Mayor-elect.

Col. S. M. MANSFIELD,
Major, United States Engineer Department.

LETTER OF MAJOR S. M. MANSFIELD, CORPS OF ENGINEERS, TO HON. R. L. FULTON, MAYOR-ELECT OF GALVESTON, TEXAS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., March 10, 1883.

DEAR SIR: I take pleasure in acknowledging the receipt of your favor of the 9th instant, expressing regret at the failure of the river and harbor bill at the last session of Congress, and noting the common apprehension that I shall be without sufficient means to carry on the work in my charge, in the progress and success of which the people of Galveston and State of Texas are so vitally concerned, and asking for such information as seems to you most important to be understood by the public authorities.

In answer to inquiries as to how long I will be able to continue work with money in hand, and as to the condition the work will be in, provided I have to suspend for want of funds, I would say I shall be enabled to continue work for about two months, at our usual rate of progress. I have, however, just reduced my force about one-half, deeming it prudent to do so, and may drag along till some time in June before laying up.

I think no injury can possibly happen to my work by reason of its being left in an unfinished state; on the contrary, it should improve with age, by reason of accretion of sand and shell. The barnacle and oyster grow rapidly on it, and serve to cement the particles of rock into a compact whole.

If we rely upon the General Government, it will probably be two years before work can be resumed. In this time our plant, which is expensive, and is now in really good order and exactly adapted to the service, will so far deteriorate as to become almost if not quite unserviceable. The expense of its renewal will then have to be borne by the first appropriation, and will so far diminish the amount of good to be derived from it.

In the interest of simple economy the work should not be allowed to stop. So far as its effect in delaying the improvement and the desired result, its effect on commerce and real values in Galveston, and its broader bearing upon the destiny of State of Texas and the States west of the great Mississippi River, I will not undertake to discourse.

It will be sufficient for me to say in answer to a further inquiry, that \$100,000 will keep the work on through the summer, and will effect the entire completion of the south jetty, giving us a wall 4 miles in length, extending from Fort Point in an easterly direction out, over, and beyond the crest of the bar, built up throughout to the level of mean low water.

The result of this concentration and training of the ebb currents upon a limited extent of the bar cannot be predicted exactly. I should be very much disappointed, however, if it did not result in a channel 18 feet deep by next fall.

When funds in hand are exhausted in June next, the condition of the work may be briefly stated thus: For the first $\frac{1}{2}$ miles out from the shore the jetty will be finished to the height of mean low water. The 6,000 feet beyond this will be incomplete, the depth of water over it ranging from 4 to 8 feet. Beyond this, and out to the end (4,200 feet) the jetty is complete, being raised here to its full height. It will be seen, therefore, that a gap in the wall of 6,000 feet is left, over which the ebb currents will discharge a large volume of water which it is most desirable to have pass over the bar and out beyond the end of the jetty, to increase by so much more the scouring capacity of the current. The \$100,000 is necessary to close this gap.

As an evidence of the value of the work already accomplished with corresponding increase of 2 feet in depth of water on the bar, I take pleasure in furnishing you with a copy of letters recently addressed to me by Messrs. Irvine & Beissner and Messrs. Adone & Lobit, and Capt. J. N. Sawyer.

Taking the tonnage of the past year as a basis of estimate, and considering only the large foreign steam and sailing vessels and New York steamship line, over \$400,000 annually is actually saved in consequence of the $\frac{1}{2}$ feet increase of water already secured, and this is a lasting benefit. It is safe to say that with but 2 feet more water on the bar, the saving will not be less than \$1,000,000 annually.

There can be no question but the benefits already secured have more than equalled the expenditures upon the improvement.

I have no doubt but a further judicious outlay will secure all the water on the bar that will be desired. As I have always said, there is no engineering difficulty in the way; it is a mere question of dollars and cents.

I am pleased to see the great interest you take in the matter, and shall assist you in whatever way I can to promote the interests of your people in successfully carrying on to completion the work in which I am earnestly engaged and which promises so well.

The keystone of Galveston's prosperity is deep water.

With regards, yours truly,

S. M. MANSFIELD,
Major of Engineers,
Bvt. Lieut. Col., U. S. A.

Hon. R. L. FULTON,
Mayor-elect, City of Galveston.

LETTER FROM MESSRS. IRVINE & BEISSNER AND ADONE & LOBIT.

GALVESTON, January 29, 1883.

SIR: In reply to the question, "What benefit to commerce, if any, has resulted from the expenditure made by the Government for the improvement of Galveston Harbor?"

we beg to say that the outlay previous to the adoption of the jetty system under your supervision did not, in our opinion, in any way improve the water on the outer bar; but since the commencement of your work we think we are safe in saying the depth of water on the outer bar has increased an average of 2 feet or more.

This increase of water has almost entirely done away with the lighterage of the class of vessels usually coming to this port, and which heretofore lightered partial cargoes. Of the larger vessels we give you at foot the names of several steamers which came to the wharves to unload, and loaded there in part, or, as in case of the Galveston, taking in the entire cargo, all of which vessels would not ordinarily have come into the inner harbor in previous years. Of the larger sail-vessels we cite the German ship Julius, of 899 tons, taking entire cargo at the wharf, while in previous years this vessel lightered up to 1,017 bales of her cotton cargo. The British ship Algona, of 1,180 tons, took 1,861 bales from the wharves, while in previous voyages the entire cargoes were lightered.

Speaking from our standpoint as lightermen, we would say that our business has been cut down from one-third to one-half, or, to illustrate in bales of cotton, we reckon that the difference, during such a crop season as the present, will exceed one hundred thousand bales in our lightering. It is impossible for us to give figures on the inward lighterage, of the one item of coal alone, this season's receipt having exceeded the entire entries of any five previous years; and the difference of 2 feet of water upon our bar would count, for sailing-vessels, about 100 tons to the foot, and for steamers nearly 300 tons to the foot.

We have thought it best to give you as near the facts in practical illustration of what difference the improvement in the outer bar has made in our branch of business, and to say further that this apparent loss is fully made good to us through the benefits which have been added to the general business of the port and the State at large, the enhanced values of realty in the city which has been placed upon a certain basis contingent only upon the completion of your work.

We would add that in our judgment but for the unusual low tides prevalent during a part of the last three months we should now have 15 feet of water on the outer bar.

Respectfully, your obedient servants,

IRVINE & BEISSNER.

ADONR & LOBIT,

Manager Galveston Steamship and Lighter Company.

Col. S. M. MANSFIELD.

Major United States Engineer Department.

MEMORANDUM OF STEAMERS REFERRED TO.

Steamship Empress brought in 1,000 tons coal on 14 feet 10 inches, and took from wharf 4,046 bales cotton on 14.2 feet.

Steamship Eastbourne 1,509 tons net, took 2,109 bales cotton from wharf.

Steamship Crystal, 1,704 tons net, took 2,292 bales cotton from wharf.

Steamship Empire, 1,437 tons net, took 1,716 bales cotton from wharf.

The above steamers would not have crossed the bar in previous years, but would have lightered entire cargoes.

Steamship Galveston, 1,308 tons net, took entire cargo, 5,750 bales cotton, from wharf; the largest cargo ever loaded in the inner harbor.

IRVINE & BEISSNER.

LETTER OF CAPTAIN J. N. SAWYER, AGENT OF THE MALLORY STEAMSHIP LINE.

OFFICE OF MALLORY LINE,

Galveston, Tex., January 29, 1883.

DEAR SIR: Your favor inquiring "what benefit to commerce, if any, has resulted from the Government expenditures at Galveston," is received.

I have not the data at hand to calculate the aggregate benefit to commerce from the harbor improvements made during the past two years; but will briefly state that the steamships of the Mallory line cross the Galveston Bar upon a draught of 2 feet more water than they could before your mattress-jetty system was commenced.

This displacement of water by the Mallory steamships engaged in the Texas trade is between 11 feet 6 inches and 13 feet 6 inches draught of water, about 200 tons weight to the foot, which, with 120 crossings of the bar in A. D. 1882, makes a total of 48,000 tons of cargo more than they could have crossed the bar with the same number of crossings in A. D. 1880, which will fairly apply in the same proportionate ratio to the

entire fleet of vessels trading to Galveston, added to which the saving in time and expense of lightering the amount of cargoes is very considerable, and the facility with which a larger class of vessels than formerly came to Galveston now discharge and load their cargoes at the wharves is evidence of decided beneficial results of the Government expenditures at Galveston.

The prospective advantage to commerce to this port, to the State of Texas, and all the vast country west of the Mississippi from a still increasing depth of water, as your work progresses, and a sufficient depth for all necessary maritime and commercial purposes which is certain to follow the completion of the jetties, is simply incalculable.

Yours very truly,

J. N. SAWYER,
Agent.

Col. S. M. MANSFIELD,
Major Corps of Engineers, U. S. A.

LETTER OF MR. J. H. METCALF, CHAIRMAN COMMITTEE ON HARBOR, GALVESTON
COTTON EXCHANGE.

GALVESTON COTTON EXCHANGE,
Galveston, Tex., January 30, 1883.

DEAR SIR: Noting that a report has been called for from all engineers connected with river and harbor improvements relative to benefits to commerce from works intrusted to their care, the committee on harbor of this exchange deem it proper to address you briefly upon a subject of such vital importance to our organization and city.

In the report of this committee to the members of Congress from Texas, in 1880, the importance of the works upon our bar was argued fully. The argument of members of our exchange before the Committee on Commerce of the Senate and House of Representatives in February, 1882, gave proof of the advance of our port. Your report to the Chief of Engineers of June last gave convincing evidence of the increased depth of water upon our bar and the consequent benefits to commerce, and needs no comment upon our part.

We feel it unnecessary to do more than add the statistics following, believing these to be such as will appeal most strongly to the good sense of members of Congress.

Respect ully yours,

J. H. METCALF,
Chairman.

Col. S. M. MANSFIELD,
Major, United States Engineers.

COTTON CARRIED BY LIGHTERS OVER BAR.

September 1, 1880, to August 31, 1881, full cotton season, 200,000; total exports, 687,000. September 1, 1881, to August 31, 1882, full cotton season, 104,000; total exports, 476,000. September 1, 1882, to January 30, 1883, five months of season, 150,000; total exports, 525,000.

As the bulk of lighterage is ever done before the 1st February, it is clear the amount of cotton taken on board ship at the dock is largely in excess of any previous season.

At the close of this fiscal year (June 30, 1883) the condition of the work was as follows:

North jetty.—The experimental piece or "trial-section" of mattress work on this line, extending out 90 feet from outer end of Bolivar gabionnade, seemed to have undergone no change during the year, and appeared to be in the same condition as when first put down.

South jetty.—This work, as extended, covers a construction of brush mattresses well ballasted with stone. The work of the past year completed the jetty, so as to give its dimensions as follows:

A foundation course 22,551 feet long, varying in width from 60 to 120 feet, and upon which is carried a second course 15 to 30 feet wide for nearly the same length. Superposed thereon are a third and fourth courses, the third course, approximately, 12,500 feet, and the fourth course (top) 4,000 feet in length.

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To protect the inner bar channel from drifting sand about 500 linear feet of sand fences were built at Fort Point.

From the report of Mr. W. A. Hinkle (published herewith) it is seen that the number of days favorable for placing mattresses was one hundred and fifty-six, and of this number sixty-seven were lost by uncontrollable circumstances. The number of mattresses placed, five hundred and thirty two, was an average of 5 for each working day.

The year's work on south jetty covered the placing of 71,657.30 cubic yards of brush mattresses and 35,897.41 cubic yards of stone ballast, aggregating 107,554.71 cubic yards of jetty work. The cost per yard (contingencies of office included) was \$2.83. Original estimate, \$3.83.

The cost of the work the previous year was \$2.88½, but the difference in cost is more marked when we take note of the difference in quantities of materials entering into the work, the cost of stone being about three times the cost of brush.

Tabulating the statement for the two years we have:

Years.	Brush.	Stone.	Total.	Cost.
	<i>Cubic yards</i>	<i>Cubic yards.</i>	<i>Cubic yards.</i>	<i>Per yard.</i>
1882.....	84,085.97	27,306.92	111,392.89	\$2.88½
1883.....	71,657.30	35,897.41	107,554.71	2.83

A recent examination and survey developed the following facts connected with this improvement, as detailed in the report of Assistant Engineer H. O. Ripley.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1894.

Excepting a reserved fund for repair of plant, care of Government property, &c., essentially necessary, the appropriation of August 2, 1882, is exhausted. The improvement, therefore, so far as concerns the General Government, has been brought to a stand-still—unable to proceed for want of Government aid, caused by the failure of Congress to pass an appropriation bill at their last session.

To prevent serious consequences arising from this state of affairs, the city authorities of Galveston took prompt measures to meet the occasion, voting an appropriation (by sale of bonds) of \$100,000 towards keeping the work going in the direction of completing the south jetty by the end of the year, if possible, with that amount.

A history of this whole transaction is appended hereto, and is as follows:

LETTER FROM HON. R. L. FULTON, MAYOR OF GALVESTON, TEXAS.

MAYOR'S OFFICE,
City of Galveston.

DEAR SIR: Inclosed please find copy of law passed by eighteenth legislature, authorizing coast cities to issue bonds for improvement of their harbors, and ordinance of the city council of Galveston, acting under said law, to issue \$100,000 of 5 per cent. bonds to improve Galveston Harbor, under the direction of the officers of the United States Government in charge at this port.

Hoping this action of the city council of Galveston will meet with a favorable response from the officers of the General Government,

I have the honor to be, your obedient servant,

R. L. FULTON,
Mayor.

Maj. S. M. MANSFIELD,
Brevet Lieutenant-Colonel, U. S. A.

AN ACT authorizing cities on the coast of Texas to appropriate money and to issue bonds for improvement of their harbors and of the "bars" at the entrance thereof, and to levy a tax to pay the same.

SECTION 1. *Be it enacted by the legislature of the State of Texas*, That the board of aldermen or other constituted authorities of cities bordering on the coast of the Gulf of Mexico are hereby authorized and empowered to appropriate money to improve and to aid in the improvement of their harbors and of the bars at the entrance thereof: *Provided*, That they shall not thereby increase their aggregate debt beyond the amount of indebtedness limited by their charters, respectively; such appropriations to be made out of any surplus funds which may at any time be on hand, and by the use or sale of any bonds heretofore authorized to be issued: *Provided*, Such bonds are not needed for the purpose for which they were specially authorized; and also, if necessary therefor, to issue and dispose of bonds with interest coupons attached in such amounts as may be necessary, not to exceed the limit of indebtedness fixed by their charters.

SEC. 2. The city council, or other constituted municipal authorities, as the case may be, shall levy an annual ad valorem tax on the property in said city, sufficient to pay the interest and create a sinking fund for the redemption of said bonds, as required by the constitution.

SEC. 3. The interest on said bonds shall be paid semi-annually, and it shall not exceed 5 per cent.

SEC. 4. Said bonds shall not be sold at less than par.

SEC. 5. Whereas the great demand for harbor improvements on the coast of Texas, and the near approach of the close of this session creates an imperative public necessity and emergency for the suspension of the rule requiring this bill to be read on three several days, and it is so suspended, and that the same take effect and be in force from and after its passage, and it is so enacted.

STATE OF TEXAS,

Department of State:

I, Jos. W. Baines, secretary of state of the State of Texas, do hereby certify that the foregoing is a true copy of the original enrolled H. D. No. 543, passed by the eighteenth legislature of Texas, approved April 7, 1883, entitled "An act authorizing cities on the coast of Texas to appropriate money and to issue bonds for improvement of their harbors, and the bars at the entrance thereof, and to levy a tax to pay for the same," and now on file in this Department.

Witness my official signature and the seal of State, affixed at the city of Austin, this 7th day of April, A. D. 1883.

[SEAL.]

P. WALTON,
Acting Secretary of State.

I certify that the foregoing act and certificate of Acting Secretary of State P. Walton, is a true copy of the originals on file in this, the office of the city clerk, of this city of Galveston.

C. T. McMAHON,
City Clerk of the City of Galveston.

AN ORDINANCE to authorize the issue of bonds to the amount of \$100,000 to aid in deepening water on the Galveston Bar, and to provide for the interest and create a sinking fund for the principal of said bonds.

Be it ordained by the city council of the city of Galveston—

SECTION 1. That the mayor and finance committee be, and they are hereby, authorized to have engraved or lithographed bonds of the city of Galveston, with semi-annual interest coupons attached at the rate of 5 per cent. per annum, payable on the first of January and July in each year at the office of the treasurer in the city of Galveston.

SEC. 2. Said bonds shall be known as the Harbor Improvement Bonds, and shall be of the denomination of \$100 each or any multiple thereof, and shall be made payable at the office of said treasurer, maturing ten years from date, and shall be signed by the mayor and countersigned by the treasurer of the city, with the corporate seal attached.

SEC. 3. Said bonds to the amount of one hundred thousand dollars (\$100,000) are authorized to be issued under and by virtue of this ordinance and in pursuance of the authority vested in the city council by an act of the Legislature of the State of Texas, entitled "An act authorizing cities on the coast of Texas to appropriate money and to issue bonds for improvement of their harbors and of the bars at the entrance thereof, and to levy a tax to pay the same," approved April 7, 1883.

SEC. 4. The bonds authorized by this ordinance shall be sold for not less than par, and the proceeds thereof shall be deposited with the treasurer, as provided for in the next section of this ordinance: *Provided*, That none of said bonds shall be issued until the full amount of the issue, viz, one hundred thousand dollars, has been subscribed for or purchasers found therefor.

SEC. 5. Said amount when obtained shall be deposited with the treasurer of the

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city and shall be used by the engineer of the United States Government in the immediate charge of the harbor improvements for deepening the outer bar of the port of Galveston, and shall be applied solely to that purpose. The said engineer shall draw drafts upon the treasurer of the city from time to time as he may need funds for prosecuting the work, and the city treasurer shall pay said drafts out of said funds until it is exhausted.

SEC. 6. To provide for the interest as it falls due and create a sinking fund for the redemption of said bonds when due there is hereby set apart and appropriated as a special fund, to be used for no other purpose, 6 per cent. of the entire revenue of the city until the principal and interest of the bonds hereby authorized are fully paid up and discharged.

SEC. 7 That an ordinance approved April 2, 1883, entitled "An ordinance to authorize the borrowing of one hundred thousand dollars to aid in deepening water on the Galveston Bar and to provide for the issue of bonds therefor," be and the same is hereby repealed.

SEC. 8. That this ordinance take effect and be in force from and after its passage.

I certify that the above is a true copy of an ordinance passed by the city council of the city of Galveston, April 16, A. D. 1883.

G. T. McMAHON,
City Clerk.

LETTER OF MAJOR S. M. MANSFIELD, CORPS OF ENGINEERS, TO THE CHIEF OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., April 24, 1883.

GENERAL: I have the honor to refer to you a copy of a letter just received from the mayor of the city of Galveston, covering copy of law passed by the eighteenth legislature of State of Texas, authorizing coast cities to issue bonds for improvement of their harbors, and an ordinance of the city of Galveston acting undersaid law to issue \$100,000 of 5 per cent. bonds to improve Galveston Harbor, under the direction of the officers of the United States Government in charge at this port, and expressing the hope that this action of the city council of Galveston will meet with a favorable response from the officers of the General Government.

I have, in consequence, the honor to request that the necessary authority be given to enable me to exercise the trust so confidently placed.

Very respectfully, your obedient servant,

S. M. MANSFIELD,
*Maj r of Engineers,
Bvt. Lieut. Col., U. S. A*

To CHIEF OF ENGINEERS, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., May 4, 1883.

SIR: Your letter of the 24th ultimo, transmitting copy of a letter from the mayor of Galveston, Tex., inclosing copy of a law passed by the legislature of Texas, and of an ordinance of the city council of Galveston, passed in accordance therewith, authorizing the issue of \$100,000 in 5 per cent bonds to be applied to the improvement of Galveston Harbor under the direction of the officer of engineers in charge of that harbor, and requesting the necessary authority to enable you to receive and apply the same, has been received.

The following copies of the indorsement of the Chief of Engineers, submitting the matter to the honorable the Secretary of War, and of the indorsement of the honorable Secretary returning the papers to this office, are furnished for your information and guidance:

"OFFICE CHIEF OF ENGINEERS, U. S. ARMY,
April 30, 1883.

"Respectfully submitted to the honorable the Secretary of War, with recommendation that the officer in charge of the improvement of Galveston harbor, Texas, be authorized to receive and disburse the funds to be provided by the city of Galveston for continuing the improvement of the harbor at that place, in accordance with the existing approved project. It being understood that the United States is to be in no way responsible for the return of the funds so provided, and assume, no obligation in relation thereto.

"H. G. WRIGHT,
*"Chief of Engineers,
"Brig. and Bvt. Maj. Gen."*

[Second indorsement.]

"The recommendation of the Chief of Engineers is approved, and the authority requested is granted upon the conditions indicated in his first indorsement hereon.

"By order of the Secretary of War.

"J. STONE,
"Acting Chief Clerk.

"WAR DEPARTMENT,
"May 3, 1883."

You will please notify the mayor of Galveston accordingly.

By command of Brigadier-General Wright.

Very respectfully, your obedient servant,

H. M. ADAMS,
Captain of Engineers.

Maj. S. M. MANSFIELD,
Corps of Engineers.

LETTER OF MAJOR S. M. MANSFIELD, CORPS OF ENGINEERS, TO HON. R. L. FULTON,
MAYOR OF GALVESTON, TEXAS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., May 14, 1883.

SIR: I have the honor to submit for your information copy of correspondence had with the Chief of Engineers, United States Army, and the honorable Secretary of War, relating to the action of the city council of Galveston in appropriating \$100,000 for the improvement of the harbor of Galveston under the direction of the officers of the United States Government in charge at this port.

It will be seen that I am duly authorized to receive and disburse the funds to be provided by the city with the express understanding that the United States is to be in no way responsible for the return of the funds, and assumes no obligations in relation thereto.

Be so kind as to acknowledge receipt and oblige,

Yours, respectfully,

S. M. MANSFIELD,
Major of Engineers,
Bvt. Lieut. Col., U. S. A.

Hon. R. L. FULTON,
Mayor of Galveston.

LETTER OF HON. R. L. FULTON, MAYOR OF GALVESTON, TEXAS.

GALVESTON, May 16, 1883.

DEAR SIR: Your favor of the 14th instant with inclosed copies of your letter to the Chief of Engineers, of April 24, and his reply thereto, were duly received and contents noted.

I am gratified to find that you are authorized, with the conditions named, to receive the \$100,000 appropriated by the city of Galveston for the continuance of your work.

Just so soon as certain preliminaries can be gone through with, consequent upon the issuance and placing of the bonds, the amount of funds named in the ordinance will be placed in the hands of the city treasurer, subject to your order.

Very respectfully,

R. L. FULTON,
Mayor.

Col. S. M. MANSFIELD,
Major, Corps of Engineers.

By virtue of the authority conferred in letter above from the Chief of Engineers, dated May 4, 1883, the work of improvement, to the exhaustion of this special fund of \$100,000 given by the ordinance above mentioned, will continue in accordance with the existing approved project. The money will be applied to the building up of the south jetty.

In addition to this action of the city authorities, I must make mention of the aid extended to the work on the part of the Galveston

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Wharf Company in granting the Government free wharfage and facilities for handling stone since the work commenced, which of itself is a very handsome contribution. No better evidence of the public spirit and desire on the part of the citizens of Galveston to secure deep water could possibly be offered, and this action is well worthy of the consideration of Congress in connection with further appropriation for the purpose.

The estimate in accordance with approved plan of 1880 was \$1,825,813
 Appropriated, 1880-'83 825,000
 1,000,813

Five hundred thousand dollars could be very profitably expended in the fiscal year ending June 30, 1885, in continuing the work of improvement inaugurated.

The work is located in the collection district of Galveston. The nearest light-houses are in Bolivar Point and Fort Point, at entrance to Galveston Bay.

Money statement.

Amount appropriated by act passed August 2, 1882 \$300,000 00
 July 1, 1883, amount expended during fiscal year, exclusive
 of outstanding liabilities July 1, 1882..... \$257,249 88
 July 1, 1883, outstanding liabilities..... 10,509 35
 267,759 23
 July 1, 1883, amount available 32,240 77
 Amount (estimated) required for completion of existing project 1,000,813 00
 Amount that can be profitably expended in fiscal year ending June 30,
 1885 500,000 00

Abstract of proposals for furnishing material, &c. (Galveston Harbor, Texas), received in response to advertisement, dated August 21, 1882, and opened September, 18, 1882, by Maj. S. M. Mansfield, Corps of Engineers.

No.	Names of bidders.	Ratline, 75,000 pounds.	Spun yarn, 40,000 pounds.	Sisal, 8-inch, 6,000 pounds.	Manila rope, 7,500 pounds.	Thimbles, 2,000 pounds.
		<i>Per pound.</i>	<i>Per pound.</i>	<i>Per pound.</i>	<i>Per pound.</i>	<i>Per pound.</i>
1	Gulf Colorado and Santa Fé Rail- way Company.....					
2	A. M. Shannon & Co.....					
3	Adolph Flake & Co.....	\$0 10½	\$0 09½	\$0 11	\$0 16½	\$0 10½
4	H. Marwitz & Co.....	10, ½	09, ½	10, ½	16	10, ½
5	W. A. Junker.....					
6	James Hopkins.....					
7	W. I. England.....					
8	Isaac Heffron.....					

No.	Names of bidders.	Tallow, 2,000 pounds.	Brush, 15,000 cords.	Stone, 15,000 tons.	Coal, 500 tons.	Handling stone.
		<i>Per pound.</i>	<i>Per cord.</i>	<i>Per ton.</i>	<i>Per ton.</i>	<i>Per ton.</i>
1	Gulf Colorado and Santa Fé Railway Com- pany.....			\$4 00		
2	A. M. Shannon & Co.....		\$3 75			
3	Adolph Flake & Co.....	\$0 08				
4	H. Marwitz & Co.....	08				
5	W. A. Junker.....		4 85			
6	James Hopkins.....					\$0 25
7	W. I. England.....					25
8	Isaac Heffron.....					34½

REPORT OF MR. W. A. HINKLE, SUPERINTENDENT.

UNITED STATES ENGINEER WORKS,
Galveston, Tex., July 12, 1883.

SIR: I have the honor to submit my report of operations on the improvement of harbor at Galveston, Tex., for the fiscal year ending June 30, 1883.

The work consisted in the manufacture and placing of mattress, repair of plant, building sand fence and dredging bar.

On hand July 1, 1882, six mattresses, 15 feet by 95 feet by 1.4 feet.

There have been constructed—

	Feet.
6 mattresses.....	30 by 95 by 1.6
5 mattresses.....	30 by 90 by 1.6
1 mattress.....	30 by 60 by 1.6
132 mattresses.....	30 by 95 by 1.7
1 mattress.....	30 by 75 by 1.7
1 mattress.....	30 by 45 by 1.7
76 mattresses.....	30 by 45 by 1.7
2 mattresses.....	30 by 30 by 1.7
7 mattresses.....	30 by 56 by 1.5
52 mattresses.....	30 by 45 by 1.5
59 mattresses.....	30 by 95 by 1.5
49 mattresses.....	30 by 90 by 1.4
27 mattresses.....	30 by 75 by 1.8
1 mattress.....	15 by 56 by 1.5
1 mattress.....	15 by 37 by 1.4
4 mattresses.....	15 by 90 by 1.4
117 mattresses.....	15 by 95 by 1.4

A total of five hundred and forty-two mattresses.

There have been placed in line of south jetty—

1. Foundation course:

40 mattresses.....	30 by 95 by 1.7
2 mattresses.....	30 by 95 by 1.6
5 mattresses.....	30 by 90 by 1.6
1 mattress.....	30 by 75 by 1.7
1 mattress.....	30 by 60 by 1.6

A total of forty-nine mattresses.

2. Second course:

123 mattresses.....	15 by 95 by 1.4
4 mattresses.....	15 by 90 by 1.4
1 mattress.....	15 by 37 by 1.4
1 mattress.....	15 by 26 by 1.4

A total of one hundred and twenty-nine mattresses.

3. Third course:

82 mattresses.....	30 by 95 by 1.7
4 mattresses.....	30 by 95 by 1.6
73 mattresses.....	30 by 45 by 1.7
52 mattresses.....	30 by 45 by 1.5
7 mattresses.....	30 by 56 by 1.5
1 mattress.....	30 by 65 by 1.7
1 mattress.....	15 by 56 by 1.5
1 mattress.....	30 by 30 by 1.7

A total of two hundred and twenty-one mattresses.

4. Fourth course:

46 mattresses.....	30 by 90 by 1.8
59 mattresses.....	30 by 90 by 1.5
27 mattresses.....	30 by 75 by 1.8
1 mattress.....	30 by 30 by 1.7

A total of one hundred and thirty-three mattresses.

An aggregate number of mattresses, placed in jetty, five hundred and thirty-two; leaving ten mattresses (30 feet by 9 feet by 1.7 feet) on hand June 30, 1883.

There have been 500 feet of sand fences built at Fort Point, in which 12 cords of brush were used.

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The following materials have been used in the work:

	Feet.
Brush	cords.. 22, 848. 12
Cane	do... 145. 02
Ratline.....	pounds.. 84, 506
Three-inch sisal rope.....	do... 10, 792
Iron thimbles.....	do... 2, 687
Spun yarn.....	do... 59, 464
<hr/>	
Stone, placing mattresses.....	cubic yards.. 29, 264. 28
Stone in riprap.....	do... 6, 633. 18
<hr/>	
Total stone.....	35, 897. 46

COST OF WORK.

Manufacture of mattresses.....	\$24, 012 65
Repair of plant.....	9, 789 59
Placing mattresses in jetty.....	29, 693 35
Storing and cost of stone.....	97, 725 34
Surveys.....	340 77
Superintendents, clerks, and watchmen.....	7, 883 88
Storing and cost of brush and cane.....	92, 675 67
Marline, rope, ratline.....	16, 048 16
Riprap.....	22, 150 63
Dredging bar.....	658 65
Other harbors.....	23 90
<hr/>	
	301, 002 59

NOTE.—Number of cubic yards of brush mattress work placed in jetty, 71,657.3.

Statement showing number of days of favorable weather and the number of mattresses placed during the year.

Months.	Number of days favorable for spiking mattresses.	Number of mattresses placed.	Number of days lost, and cause.
<hr/>			
1882.			
July	18	59	One holiday; one day, no mattresses on hand for third and fourth course; one day riprapping.
August.....	22	24	Four days, riprapping; seven days, no mattress on hand; seven days, tug Cynthia under repair; one day, Sunday.
September.....	15	83	One day, riprapping; one day, no stone loaded, no mattresses on hand; one day, Sunday.
October	18	76	Three days, riprapping; one day, no stone or mattress on hand; two days, Sundays.
November	14	55	One day, riprapping; two days, no mattress on hand; one day, placing barge aground; one day, tide too low; one day, out of brush.
December	13	26	Two days, riprapping; three days, no mattress on hand.
1883.			
January	11	42	Three days, riprapping; one day, tide too low.
February	7	38	Three days, owing to strong tides, could not place mattresses.
March	10	45	One day, riprapping.
April	7	83	One day, tug Cynthia went to Brazos River with Colonel Maunfield.
May	8	24	One day, towed placing-barge to Morgan's Point to haul out; one day, riprapping.
June	23	27	Two days, riprapping; one day, not sufficient men; two days, surveying; one day, no mattress on hand; one day, placing barge aground; four days, dredging bar; three days, Sundays.

Six mattresses were lost by breaking loose from tow of tug Cynthia, owing to heavy sea running. None have been lost from jetty.

REPAIRS TO PLANT.

Tug *Cynthia* was hauled out twice, hull cleaned, and machinery overhauled; tug *Molyneux* was hauled out, and hull and machinery repaired; placing-barge was hauled out, and hull repaired.

The plant, with the exception of barges 2, 3, and 4, which require some attention to their sheathing, is in good condition for constant and efficient service.

Respectfully,

W. A. HINKLE,
Superintendent.

Maj. S. M. MANSFIELD,
Corps of Engineers.

REPORT OF MR. H. C. RIPLEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., August 21, 1883.

SIR: I have the honor to submit the following report relating to the survey of Galveston Harbor, Texas:

The survey was commenced on the 12th of May, and concluded on the 21st of July ultimo, having been prosecuted during favorable weather and at such times as not to interfere with more important work. The actual time consumed in the hydrographic work was forty-nine and one-half hours, embraced in portions of twelve days. The area covered is 16 square miles, extending from near the quarantine station, in Galveston channel, to the Gulf, and embracing the inner and outer bars.

The accompanying tracing shows a plot of the survey, together with a sectional elevation of the south jetty as constructed up to June 30, 1883.

Comparing this survey with that of June, 1882, we note the following changes, all depths referring to the plane of mean low tide: There has been a deepening at that point in Galveston Channel west of the Fort Point light-house, where a shoal had formed, arresting the 18-foot contours, so that now there is a least depth of 18½ feet.

There has also been a deepening on the site of the inner bar, which can now be crossed with a least depth of 25 feet, there being as much as 27½ feet depth between it and the shoal above mentioned.

In Bolivar Channel little change is to be noted inside of the 18-foot contour. There is an undoubted tendency, however, to straighten the southward deflection existing at its outer end.

At the extreme point of the bight the 18-foot contour has moved to the north and east about 800 feet. Farther north this contour has moved eastward from 400 feet to 1,500 feet, and on the north side of the channel for a short distance from its eastern end it has moved south from 200 feet to 500 feet.

These movements, however, are effected with a slight change in depth, on account of the nearly level bottom; but as we approach the crest of the bar, following the line of the axis of Bolivar Channel nearly, we find a bight of the 16-foot contour to have advanced fully 1,500 feet, showing a scour in places of over 3 feet depth.

In the jetty channel at the shoalest point there has been a deepening of 1½ feet, so that there is now a least channel depth of 13 feet, and a width of 1,000 feet from the jetty to the 12-foot contour north of it. Aside from the deepening in the jetty channel, the depth on the crest of the bar remains practically unchanged; the bar, however, has moved gulward some 300 feet, and the area between the 12-foot contours has diminished in width a perceptible amount.

South of the jetty for the outer 2 miles but little change has occurred; the same trench exists close to the jetty, which at a point about 1 mile from the outer end of the jetty has widened somewhat; this is obviously caused by the escape of water through the gap in the upper courses of the jetty at this place.

Nearer the shore the shoals have somewhat changed in position and shape; the 8-foot contour outside of the first shoal met has moved shorewards about 500 feet, except in a narrow ridge near the jetty, where it has pushed out about 1,200 feet.

The swash channel has greatly diminished in both width and depth, and an accretion of some 200 feet has been made to the shore, in addition to numerous ridges, which have made their appearance above the water surface.

Along the north face of the jetty, where it crosses the shoal near the Fort Point light, a trench has been excavated by the overfall of water which comes in through the swash channel, and which is deflected from its accustomed route by the building up of the inner end of the jetty. That portion of this shoal lying north of the jetty has been depressed on the north and west, and extended on the east, the 6-foot contour having advanced eastward nearly 1,000 feet. The eastward advance of this shoal has so much encroached upon the channel, which crossed the line of the jetty about 1 mile east of Fort Point light, that it would seem to be only a matter of a few months' time when this channel will be entirely filled.

The shoal south of the light-vessel has changed very little. The northwest corner has been depressed slightly, and northeast corner extended about an equal amount. At the east end the 12-foot contour has moved west. At one point this movement amounts to 500 feet. At the time of the previous survey the movement of this shoal was in the opposite direction, and it is believed that it will resume its eastward advance when the gap in the jetty at this point is closed.

The area north of Bolivar Channel was not covered by the survey of last year. Comparing it, therefore, with the survey finished in February, 1881, we find the shoal extending out along the north side of the channel has experienced no change. Its western limit embraced in this survey has been narrowed somewhat by the enlargement of the swash channel at that point, and its eastern end has moved to the north, an amount corresponding nearly with the northward movement of Bolivar Channel at its eastern extremity.

The 8-foot contour has moved easterly, inclosing a narrow ridge for a distance fully 2,500 feet.

The 12-foot contour to the north has moved out about 400 feet.

Between the 12-foot and 18-foot contours a remarkable shoaling has occurred. The 18-foot contour having moved gulward at one point over 2,000 feet. There is no evidence of a trench for much of the distance along the line of the Bolivar Gabionade, but where it was deepest it has greatly shoaled, and in places no evidence of a trench remains. The shoal which crosses the swash-channels south of the gabionade has increased in width 500 feet, and has moved southwestward a like amount. The north side of Bolivar Channel, between the 8-foot and 20-foot contours, seems to possess a remarkable degree of permanency.

Altogether the changes for the past year, or indeed for the two years past, considered the magnitude of the jetty already constructed, are very slight, and indicate rather the direction towards which changes are tending than any very important results accomplished.

The straightening of Bolivar Channel at its outer end is evidence of the success which the current in that channel gets from the jetty in its efforts towards a straight passage into the Gulf in opposition to the littoral current, which tends to deflect it to the southward.

The gulward movement of the bar, without a corresponding increase in depth up to its crest, would seem to indicate the importance of an early and rapid construction of the north jetty.

The changes thus far do not seem to warrant the expectation of a much greater increase in depth in the present jetty channel, but the indications seem to point to a new channel at a much greater distance from the jetty and more nearly on the prolongation of the axis of Bolivar Channel.

The closing of the gap in the third and fourth courses of the south jetty will undoubtedly hasten this result by diminishing to a great extent the cross-current on the bar, which is produced by the littoral current.

In conclusion, I desire to express my indebtedness to Lieut. W. L. Fisk, Corps Engineers, Mr. J. M. Picton, assistant engineer, and Mr. H. J. Condon, for valuable assistance in the conduct of the survey and construction of the chart.

Very respectfully, your obedient servant,

H. C. RIPLEY,
Assistant Engineer

Maj. S. M. MANSFIELD,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, GALVESTON, TEX.,
Collector's Office, July 24, 1883

District of Galveston, year ending June 30, 1883.

Trade.	Entered.		Cleared.	
	No.	Tonnage.	No.	Tonnage.
Coasting	472	405, 771	329	288, 106
Foreign	258	156, 795	265	166, 106
Total	730	562, 566	594	454, 212

Value of exports:	
Domestic	\$29,637,898 00
Foreign	11,062 00
Number of bales cotton exported, 517,258, or 269,274,602 pounds.	
Value of foreign merchandise:	
Imported	\$1,547,374 00
Total receipts from all sources	545,030 74

P 2.

IMPROVEMENT OF SHIP-CHANNEL IN GALVESTON BAY, TEXAS.

Original estimate (for channel 100 feet wide and 12 feet deep), 1877.....	\$446,326 42
Appropriated, 1872 to 1883.....	446,500 00

The improvements made and condition of the channel at the close of the fiscal year ending June 30, 1882, covered the following:

First. A channel between Bolivar Channel and Red Fish Bar, 12 feet deep and 100 feet wide at bottom.

Second. A channel through Red Fish Bar and through the Upper Bay, carrying a least depth throughout of 8½ feet at mean low tide, with work of dredging (under contract with Mr. James E. Slaughter) progressing.

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1883.

Mr. James E. Slaughter, under his contract of July 7, 1881, continued work of dredging from July 1, 1882, to June 1, 1883, when it was found that he had completed all the work required of him under the terms of his said contract. This work covered the excavation and removal of 962,229 cubic yards of material from the channel, giving an average 13 feet depth from Red Fish Bar to Morgan's Cut through the Upper Bay.

The work progressed unsatisfactorily during the months of July, August, September, and October, and the greater part of November, owing to insufficient plant. In November an additional dredge and tug was put upon the work, after which the progress of the work was all that could be desired.

The project for the expenditure of the funds of 1881, \$50,000, and 1882, \$94,500, mentioned in last annual report, was not elaborated. The reasons for non-complying with that proposed duty are fully set forth in my letter of November 21, 1882, to the Chief of Engineers. This letter, together with a report of a Board of Engineers, with accompanying recommendation and orders, is given herewith in full to complete the record.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1884.

The funds of the appropriation of 1881-'82, \$144,500 in compliance with the orders of the Department, as above mentioned, are reserved for such action as Congress at its next session may make. Therefore, nothing can be done until after the requisite Congressional action is had, and for the reason it is impossible now to outline the coming year's work upon this improvement.

The work is in the collection district of Galveston. The light-houses on or near the line of work are, (1) at Bolivar Point; (2) at Fort Point; (3) at Half-Moon Shoal; (4) at Red Fish Bar.

Money statement.

July 1, 1882, amount available.....	\$88,466 13
Amount appropriated by act passed August 2, 1882	94,500 00
	<hr/> 182,966 13
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	23,095 63
July 1, 1883, amount available.....	<hr/> 159,870 50

LETTER OF MAJOR S. M. MANSFIELD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., November 21, 1882.

GENERAL: I have the honor to present the following as pertinent to the subject of developing and maintaining a 12-foot ship-channel through Galveston Bay, Texas, in the manner carried on by the United States since 1874, under appropriations for "improving ship-channel in Galveston Bay, Texas," and otherwise.

From the several annual reports it is learned that—

First. First estimate was made in 1871, by Lieutenant Adams, for 6-foot channel, 100 feet wide, through Red Fish Bar for accommodation of steamboat traffic, \$62,805, with an additional annual appropriation (unknown amount) necessary for maintenance of such a channel. Also, estimates for channel 6 by 150 feet through the two bars, and for ship-channel 150 by 12 feet from Bolivar Channel to San Jacinto River. (The average depth of Galveston Bay, $8\frac{1}{2}$ feet, with bottom of soft mud, sand, and shells.) *Stated*, that last channel will not remain open, but will either require constant dredging, or must be revetted on both sides for a distance of 20 miles, with the certainty that the revetment would be destroyed by the *Teredo navalis* in a few years.

Captain Howell approved of first plan, but increased estimate from \$62,805 to \$125,000.

Second. First appropriation, \$10,000, was made June 10, 1872, with which channel was dredged by Government dredge through Red Fish Bar, 1,500 by 70 by $7\frac{1}{2}$ feet, at a cost of 51 cents per cubic yard, depositing material on sides of cut.

Third. Second appropriation, \$10,000, made June 23, 1874, was applied to extending above-named cut 2,982 feet, connecting $7\frac{1}{2}$ -foot depths above and below bar, 60 feet wide.

Fourth. Third appropriation, \$10,200, made March 3, 1875, for widening to 150 feet and deepening to 10 feet, for accommodation of increasing commerce.

Fifth. Fourth appropriation, \$25,000, made March 3, 1875, is the first for the "Improvement of the ship-channel between the mouth of the San Jacinto River and Bolivar Channel, in Galveston Bay," and considered as continuation of Red Fish Cut.

Sixth. In submitting estimate for completion of 9-foot cut through Red Fish Bar, and for 10-foot, 12-foot, and 15-foot ship-channels, nothing was included for protection by embankment or piling, as it was thought the channels might be free from silting, reasoning from a somewhat similar cut in Atchafalaya Bay (since greatly filled).

A 10-foot channel was recommended as sufficient for the time being, with proviso that it should be cut to a depth of 12 feet, to allow for filling by pressure from sides.

Seventh. The channel finished through Red Fish Bar in 1876 was 6,100 feet long, with least depth of $14\frac{1}{2}$ feet at mean low tide, and connected depths of 9 feet and $8\frac{1}{2}$ feet in upper and lower bays, permitting passage of vessels of 9 feet draught to within a few miles of Houston.

Report of 1876, page 586, letter from C. A. Whitney & Co., July 20, 1876, states that no shoaling had then taken place in the excavated channel, and mentions the commercial importance of the work.

Eighth. Fifth appropriation, \$72,000, made available April 25, 1877. No work was done during that year, because the line of channel had not been definitely decided upon.

Ninth. Project was submitted May 21, 1877, for excavation of channel 12 feet deep and 100 feet wide at bottom, from Red Fish Bar to either Morgan's Cut or mouth of San Jacinto, with preference given to the former as being \$200,000 cheaper. This matter was referred by the Chief of Engineers to the Secretary of War for the reason that it involved the subject of tolls made by the Ship-Channel Company. Appropriation was therefore held in reserve.

Tenth. In 1877, Assistants Hayward and Ripley, reported on the upper and lower bays, respectively, and made estimates for channels 12 feet deep and 100 feet, 150 feet, and 200 feet wide.

Estimates for 12-foot channel 100 feet wide on lines afterwards selected were \$160,994.92 for upper bay, and \$146,856.75 for lower bay. No estimate for work in Morgan's Cut.

Mr. Ripley's report (with current discussion) appears on page 462, Report Chief of Engineers, 1877, and recommends a straight line from Red Fish Cut to the head of Bolivar Channel. On page 467 of same year's Report is found the report of the Board of Engineers deciding in favor of this line.

Eleventh. Captain Howell (page 918, Report of Chief of Engineers, 1879), states that work (by dredging) cannot be considered permanent, for filling will certainly occur; also that no estimate can be made for its maintenance until data showing amount of fill can be obtained.

Major Mansfield (page 1236, Report of Chief of Engineers, 1880) also states work of simple dredging is not considered permanent.

Twelfth. Condensed history of operations appears in Report of Chief of Engineers, 1881, page 1332; and correspondence relating to surrender of rights by the Ship-Channel Company, under certain conditions, appears on pages 1334-1340 of the same Annual Report.

Thirteenth. No appropriation has been made for reimbursement of the Buffalo Bayou Ship-Channel Company in view of its surrender of charter and rights.

Fourteenth. Assistant Hayward's estimate of cost of a close-pile revetment (pine) was \$3 per linear foot, not creosoted or protected in any way.

Fifteenth. Appropriated:

1875	\$25,000
1876	72,000
1878	75,000
1879	80,000
1880	50,000
1881	50,000
1882	94,500
Total	446,500

which was the amount of Major Howell's final estimate of 1877.

Sixteenth. Under combined appropriation of 1876-'78, \$147,000, a contract was entered into with George C. Fobes & Co. for dredging in lower bay, from Bolivar Channel to Red Fish Bar.

Work begun May 14, 1879, and was completed the end of May, 1880, when was reported a channel 100 feet wide and 12 feet deep as the result; 703,646.63 cubic yards were removed during the year's time occupied on the work under this contract.

An examination of this line of cut was made October 2, 1882, which shows that there has been a fill throughout the entire length of cut. This fill amounts to 2.91 feet as a mean of nineteen cross-sections. The maximum fill was 4.3 feet, and the minimum fill was eight-tenths of a foot. The greatest depth in the minimum cross-section was 8.9 feet at mean low tide.

Seventeenth. Under the appropriation of 1879, \$80,000, together with that of 1880, \$50,000, contract was entered into July 7, 1881, with James E. Slaughter, for dredging a channel 100 feet wide and 12 feet deep between Red Fish Bar and Morgan's Cut.

Work began March 30, 1882, and has progressed slowly, as might be expected with the insufficient plant furnished by the contractor, till the present time. About one-half of the work is completed at this date (November 21), but a promise of another dredge (just arrived) on the work will hasten its progress, and the entire work may be completed by the 1st of April, 1883.

Eighteenth. After this there will remain \$168,500, covering the balance of appropriation of 1878, \$24,000, the appropriation of 1881, \$50,000, and the appropriation of 1882, \$94,500, which was made to fill the original estimate to complete a channel 100 feet wide and 12 feet deep between Bolivar Channel and Morgan's Cut.

CONCLUSION.

The prediction that this dredged channel would not be permanent is, I think, abundantly verified by the results shown by our recent examination.

To carry out the approved project would be a simple matter, *i. e.*, to continue dredging as we have done and are now doing; but then remains the certainty of the cut filling up in a very short time, leaving the bay in its former condition, navigable only for vessels of light draught. I therefore feel obliged to submit this matter for advice, not being able to bring myself to the point of *recommending an expenditure* of the large sum of money now in hand and available for this improvement *in dredging* in this open bay.

Hence, not being able to submit a project, I submit this as a complete statement for the attention of the Department, and await instructions.

Very respectfully, your obedient servant,

S. M. MANSFIELD,

Major of Engineers, Bvt. Lieut. Col., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., February 24, 1883.

GENERAL: The Board of Engineer Officers, consisting of Maj. S. M. Mansfield, Capt. A. N. Damrell, and Capt. W. H. Heuer, constituted by Special Orders No. 9, dated Headquarters Corps of Engineers,

Washington, D. C., January 29, 1883, met at Galveston, Tex., on the 14th and 15th instant, to consider the subject of the further prosecution of work in continuance of the improvement of ship-channel in Galveston Bay, Texas, and report its conclusions in regard to the permanency of said channel and the means to be adopted for securing such permanency, with estimate of cost, &c.

Such information as was available and necessary to an understanding of the subject was presented by Major Mansfield, and the subject was carefully discussed.

The Board have the honor to report: A history of the work pertinent to this consideration may be briefly given. The first work of dredging undertaken by the Government was done in 1872-'73, under an appropriation of \$10,000, and consisted of making a cut across Red Fish Bar through what was known as West Pass. This cut was 1,500 feet long, 70 feet wide, and of a depth to admit vessels drawing 7 feet, the material being deposited on the side of the cut. (See Chief of Engineers' Report for 1873, page 634.)

Under an appropriation of \$10,000, made June 23, 1874, work was continued, resulting in the extension of the cut made in 1872-'73, so as to admit the passage of vessels drawing $7\frac{1}{2}$ feet. The extension was 2,982 feet in length, 60 feet wide, from $7\frac{1}{2}$ to 10 feet deep, and made connection between $7\frac{1}{2}$ feet water in the bay above and below the bar. (See Chief of Engineers' Report for 1875, page 870.)

In 1875-'76, two appropriations, made in 1875, aggregating \$35,200, were expended under contract in making a new cut across Red Fish Bar, (the old cut having been abandoned for reasons not definitely known). The channel dredged was 6,100 feet in length, and had a minimum depth of $14\frac{1}{2}$ feet at mean low tide, and connected depths of 9 feet and $8\frac{1}{2}$ feet in the upper and lower bays.

About this time the Buffalo Bayou Ship-Channel Company made a canal across Morgan's Point from San Jacinto River to the bay and extended a dredged channel in the bay towards Red Fish Bar for a distance of about 5 miles. These are known as Morgan's Canal and Cut. The width of the channel through the land at Morgan's Point was 180 feet, that of the channel in the bay 120 to 150 feet; the depth of channel was from 13 to 17 feet at time of completion, according to statement of Charles A. Whitney & Co. (See Chief of Engineers' Report for 1876, page 587.)

In the winter of 1876-'77 a survey was made which showed that an undoubted fill had taken place in Morgan's Cut, since its completion, there being at that time, for considerable distances in the cut, less than 12 feet depth. It also showed that the old cut across Red Fish Bar had become almost entirely obliterated.

This survey was made for the purpose of deciding upon the location of the lines of cut to complete the ship-channel through the bay, and resulted in the decision to connect Morgan's Cut and Red Fish Cut in the upper bay and Red Fish Cut and Bolivar Channel in the lower bay by straight cuts.

The location of the cut in the lower bay was referred to a Board of Engineers, which states, with regard to this line in preference to a line passing to the West of Pelican Island, that it would be shorter, with fewer necessary curves (if any) in its course, would require a much smaller amount of dredging in its first construction, and could afterwards be maintained at less cost. (See Chief of Engineers' Report for 1877, page 467.)

Between May, 1879, and May, 1880, \$147,000 were expended in dredg-

ing on this line, which resulted in a channel 100 feet wide and 12 feet deep at mean low tide, extending from Boliver Channel to Red Fish Cut, a distance of $9\frac{1}{2}$ miles; the amount of material excavated was 703,646 cubic yards.

An examination of this line of cut was made October 2, 1882, which shows that there has been a fill throughout the entire length of cut. This fill amounts to 291 feet as a mean of nineteen cross-sections. The maximum fill was 4.3 feet, and the minimum fill was eight-tenths of a foot. The greatest depth in the minimum cross-section was 8.9 feet at mean low tide. The amount of fill in cubic yards for two and one-third years is approximately 543,000, or, assuming that the fill has been uniform, at the rate of 232,714 cubic yards per year.

A recent examination of the lower end of Morgan's Cut shows that it has become entirely filled as far as examined. This leads to the conclusion that the entire cut from Bolivar Channel to Morgan's Point is wanting in permanency save, perhaps, that portion immediately through Red Fish Bar, and even this subject to shifting in position, if not to actual fill.

No use has ever been made of the cut through the lower bay. The Morgan steamers are the only deep-draught vessels plying this route, and two reasons may be assigned for their not using it: First, the cut was not sufficiently marked to enable them to keep in it; and, second, there was as much water in the bay outside of the cut as in Atchafalaya Bay, or on the bars of the Texas ports which they had to cross either before or after their passage through the bay.

Captain Atkinson, superintendent Houston Direct Navigation Company, was before the Board and stated that if vessels had used the cut, he believes that it would have refilled more rapidly than it did.

With reference to the further prosecution of the work, we can only give the facts as they exist, and state the cost of reopening and maintaining the channel.

When the project was made in 1876 to get a 12-foot channel to Houston there was but 12 feet on the Galveston Bar. Any vessels, therefore, which could cross the bar could go direct to Houston with the consummation of this project. There was also inaugurated about this time a scheme making Clinton (a point near Houston) a transfer point for the Texas Central Railroad and the Morgan steamers, by which commerce was carried on between New Orleans and the interior of Texas. Since then, however, the conditions have very materially changed.

The increased depth on the Galveston Bar renders 12 feet depth through the bay insufficient for a sea-going vessel without lightering, and the completion of the railroad through from Houston to New Orleans and changes in the railroad system of Texas is about to result in the abandonment of Clinton as a transfer point. About 140,000 tons freight represents the business at this point for the two years 1881 and 1882.

The only interest to be subserved, therefore, is the local commerce between Houston and Galveston, and there is water enough, in our judgment, at present (8.9 feet), to accommodate this commerce as at present served by the Houston Direct Navigation Company's tugs and barges, which was, for the years—

	Tons.
1879.....	122,505
1880.....	178,872
1881.....	187,877
1882.....	109,662

CONCLUSION.

We see no reason to believe that any line other than the one selected, and which was recommended by the Board of Engineers, to which the matter was originally submitted, offers superior advantages for a dredged channel, and we do not know that a wider and deeper cut would be any more permanent than the one already made, and we know of no other method by which a permanent channel can be made through this long stretch of shallow bay at any reasonable cost. The Red Fish Bar Cut, which was made both wider and deeper, has proved far more durable than those made by the Government in other portions of the bay, and this might indicate that a wider and deeper cut would endure longer than that which has nearly refilled; but the Morgan Cut, dug 13 to 17 feet deep and 120 to 150 feet wide, filled quite as rapidly as cuts made by the Government under similar circumstances.

The maintenance of the Red Fish Cut is undoubtedly due to the concentration there of a large volume of water and consequent strong current through it. We believe that if the Government purposes maintaining a 12-foot-deep channel in Galveston Bay it may be done by making a wider and deeper cut than the original one was, or by making a recut of the original width and depth (averaging 100 by 4 feet), with a heavy annual expenditure for maintenance.

Judging by the filling which has occurred in the present channel in the past two and one-third years, we estimate roughly that the annual approximate cost of such dredging will be \$90,000.

With a cut 200 feet wide, 4 feet deep, we believe there would be a partial refilling, which, after a few years, would require removal, and while we cannot state the exact cost and maintenance of either channel, we believe that the total cost to the Government for a navigable channel 12 feet deep would, including original cost and maintenance, be about the same, whether the first cut be made wide or narrow. We know that a narrow cut fills rapidly. A wider cut may fill less rapidly.

Had the appropriations been made available as fast as the work could have been pushed, so that work could have been prosecuted in both the upper and lower bays simultaneously, it is probable that a 12-foot channel throughout could have been obtained with the amounts appropriated. As it was, however, the cut in the lower bay was filling while that in the upper bay was being made.

The funds (\$168,500) available for this work will be sufficient to re-open the channel in the lower bay. In the light of the experience as shown above, the benefits to commerce, however, will be small unless annual expenditures are made for maintenance.

The channel has ever been reported upon as wanting in permanency.

We are also of the opinion that if the channel should be re-opened the cut should be well marked by piles not over 1,000 feet apart throughout its entire length.

An inspection of the work was not deemed necessary, as the maps and surveys were sufficiently complete in detail, and of a recent date.

Respectfully submitted.

S. M. MANSFIELD,
Major of Engineers, Bvt. Lieut. Col., U. S. A.
A. N. DAMRELL,
Captain of Engineers.
W. H. HEUER,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 17, 1883.

SIR: The report of the Board of Engineers, constituted by Special Order No. 9, Headquarters Corps of Engineers, "to consider and report upon the best method to be adopted for further prosecution of work in connection with the dredged channel through Galveston Bay," submitted with your letter of the 3d instant, was duly received.

The following copies of the indorsement of the Chief of Engineers, submitting the report to the honorable the Secretary of War, and of the indorsement of the Secretary approving the same, are furnished for your information and guidance:

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 12, 1883.

Respectfully submitted to the honorable the Secretary of War, with recommendation that none of the funds now available (beyond what is needed to cover the existing contract) for "improving ship-channel in Galveston Bay, Texas," be expended until the further action of Congress is had thereon, and that the matter be made the subject of a special communication to Congress at its next session.

It would seem from the within report of the Board of Engineers that the improvement cannot be made a permanent one at any reasonable cost, that the cost of maintenance would be about \$90,000 per annum, and that the necessity for the channel is far less than formerly and is not now called for in the interests of commerce.

H. G. WRIGHT,
*Chief of Engineers,
Brig. and Bvt. Maj. Gen.*

[Second indorsement.]

The recommendation of the Chief of Engineers is approved.
By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

WAR DEPARTMENT,
March 15, 1883.

By command of Brigadier-General Wright,
Very respectfully, your obedient servant,

JOHN G. PARKE,
*Lieut. Col. of Engineers,
Bvt. Maj. Gen., U. S. A.*

Maj. S. M. MANSFIELD,
Corps of Engineers.

P 3.

IMPROVEMENT OF TRINITY RIVER, TEXAS.

Estimate of 1880, dredging bar and removing snags above and below Liberty, and dredging on the bar at the mouth of the Middle Pass..... \$36,541

The condition of the improved portion of the river—simple improvement of dredging and snagging in 1879, 1880, and 1881—remained about the same as was reported in last annual report, having (as far as known) a least depth of water in channel of 5 feet from the entrance over the bar at Liberty.

No work appeared to be needed upon the river at any time during the year, and no work was done; and the

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1884,

will in a great measure depend upon what commerce may demand for safe and rapid navigation along the stream.

The funds now in hand (appropriation of 1881 and 1882), \$14,000, will meet the requirements for dredging and snagging, if found necessary during the year.

In case commerce requires the development of the river beyond its present capacity for navigation, it is thought that the estimate (required for completion of existing project) of \$14,541 will be sufficient to meet such conditions for a year or so to come; but there exists no basis for estimate as to the length of time the cuts made through the bar at the mouth and the bar near Liberty will remain open for navigation, or as to the cost of maintaining the river from its mouth to Liberty in a navigable condition.

Appropriated 1878 to 1883, \$34,500.

No appropriation is asked for the next fiscal year, none being needed because of the present lack of river commerce.

The work is located in the collection district of Galveston; nearest light-house, Red Fish Bar, Galveston Bay.

Money statement.

July 1, 1882, amount available.....	\$6,630 91
Amount appropriated by act passed August 2, 1882.....	8,000 00
	<hr/>
	14,630 91
	<hr/>
July 1, 1883, amount available.....	14,630 91
Amount (estimated) required for completion of existing project.....	14,541 00

P 4.

IMPROVEMENT OF BUFFALO BAYOU, TEXAS.

Estimate of 1880, for channel 100 feet wide and 12 feet deep, between Simm's and White Oak Bayou	\$385,299 75
Appropriated, 1881-'83	75,000 00
	<hr/>
Unappropriated.....	310,299 75

The work accomplished and improvement made up to June 30, 1882, covered the work (as commenced under the contract of September 1, 1881, with Mr. G. L. Long) of removing snags, logs, stumps, and earth, 24,895 cubic yards, and the clearing away of overhanging trees, &c., 11.2 miles of bank.

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1883.

The contract of September 1, 1881, with Mr. Long, was in force the beginning of July, and the work of deepening, widening, and straightening the channel was continued until the 18th of November, at which time the funds available for expenditure under Mr. Long's contract were exhausted.

The total work accomplished by Mr. Long, under the terms of his contract, comprised the following:

The clearing of the banks of the stream of overhanging trees, &c., for a distance of 11.2 miles, from Simm's Bayou to within 2 miles of

Houston; the removal of obstructions in the bed of the stream by dredging away 98,910 cubic yards of stumps, logs, snags, and earth, reducing shoal places below Houston where found necessary.

The work done was satisfactory in every respect.

A project for the expenditure of the funds (\$50,000) appropriated by act of Congress passed August 2, 1882, was forwarded September 30. The project recommended work in continuation of that already done, viz, deepening, widening, and straightening channel, and removing all obstructions to navigation, to the extent of the limited amount of funds in hand therefor.

The following is an abstract of bids received in response to my advertisement:

Abstract of proposals for improving Buffalo Bayou, Texas, received in response to advertisement dated September 30, 1882, and opened October 26, 1882.

No.	Names of bidders.	Dredging earth.	Removing overhanging trees.	Revetting banks.	Removing stumps and sunken trees.
		<i>Cubic yds.</i>	<i>1,000 sq. feet.</i>	<i>Linear feet.</i>	<i>Log or stump.</i>
*1	John J. Atkinson	\$0 26	\$0 75	\$8 50	\$3 00
2	John Maguire.....	27	12 00	6 25	4 00

* Lowest bidder.

The contract with Mr. John J. Atkinson was signed November 11; work to commence on or before December 15, and to be completed by the 30th of June, 1883.

Mr. Atkinson began work on the 15th of November, by clearing the left bank of the stream from Harrisburg to Clinton of trees and underbrush, and by dredging and snagging in the upper portion of the bayou near Houston.

From the 15th of November to, and inclusive of, the 30th of June the following was accomplished under this contract:

1. Removed from shoal and narrow places on the bayou, 88,765 cubic yards of material.

2. Removed from bed of the stream 971 stumps and sunken logs.

3. Cleared the banks of overhanging trees, underbrush, &c., covering a space of (in the aggregate) 1,247,810 square feet of bank.

The work has been carried on in a most satisfactory manner, and the improvement thus far made with the limited expenditure of funds is effectively shown. Personal examinations during the year have proved conscientious, painstaking work on the part of the contractor, coupled with a desire to perform the work of his contract so that by its fulfillment the present and future requirements of navigation may be equally benefited.

On the 10th of June (finding that it would be utterly impracticable to complete the contract within the fiscal year as required) the contractor applied for an extension of time. The application, favorably indorsed by me, received the approval of the Chief of Engineers on the 26th of June, and an extension to October 31, 1883, was granted.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1884.

Dredging, snagging, &c., to completion of contract with Mr. John J. Atkinson, and to exhaustion of available funds. It is thought that all work will be completed soon after the 1st of September, when further operations will cease for want of money.

One hundred thousand dollars could be profitably expended in making the improved channel required for navigation during the fiscal year ending June 30, 1885.

It is in the collection district of Galveston, and the nearest light-houses are those in Galveston Bay, and at Fort Point, at the entrance to Galveston Harbor, Texas.

Money statement.

July 1, 1882, amount available.....	\$860 98
Amount appropriated by act passed August 2, 1882	50,000 00
	<hr/> 50,860 98
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$22,937 99
July 1, 1883, outstanding liabilities	24,762 17
	<hr/> 47,700 16
July 1, 1883, amount available.....	3,160 82
	<hr/>
Amount (estimated) required for completion of existing project.....	310,299 75
Amount that can be profitably expended in fiscal year ending June 30, 1885.	100,000 00

COMMERCIAL STATISTICS.

HOUSTON, July 15, 1883.

DEAR SIR: I respectfully submit for your consideration the following statistics respecting the city of Houston and the commerce of Buffalo Bayou, in addition to those contained in the memorial of the Houston Cotton Exchange and Board of Trade of the city of Houston, presented to Congress March, 1882, and those presented in your reports to the Chief of Engineers, United States Army, for previous years, and to which reference is respectfully made.

The population of the city of Houston is estimated at 25,000; taxable wealth, \$8,000,000.

There has been a marked increase of the trade and manufactures of the city in the past year. The leading features of improvement have been the completion of the Southern Pacific Railway, introduction of the electric light, the construction of another line of street railway, and the erection of another powerful cotton compress by the Inman Company, a firm largely engaged in foreign trade from this port; this gives Houston five first-class cotton compresses. The foreign exports through Galveston Bay have been heavy, particularly in cotton, cotton-seed oil, and oil cake, and, while the foreign imports have not been so great, there has been a large increase in the direct coastwise trade, particularly with Atlantic ports.

The following statement of railroads now centering at Houston shows the number of miles operated in Texas:

Houston and Texas Central	762
Southern Pacific	848
International and Great Northern	847
Gulf, Colorado and Santa Fé	535
Houston, East and West Texas	142
Texas Western	53
Galveston, Houston and Henderson	50
Texas and New Orleans	117
Texas Transportation Company	8
Houston and Columbia	50
Total	<hr/> 3,412

The freights handled at Houston by its railroads for the year ending August 31, 1883, are estimated at 3,755,200,000 pounds.

Of the above it is estimated that the following were the products of Texas:

	Pounds.
Cotton, 715,000 bales	357,500,000
Wool	8,224,000
Live stock	35,600,000
Hides, tallow, &c.	6,130,000
Grain, Hay, &c.	109,000,000
Lumber	110,000,000
Sugar and molasses	7,225,000

The sales of merchandise and manufactured articles are estimated at \$18,750,000.

1086 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

HOUSTON COTTON STATEMENT.

	Bales.
Gross receipts year ending August 30, 1882.....	413, 806
In transit.....	136, 926
Net receipts for Houston market.....	276, 880
Gross receipts, inclusive of June 30, 1883	715, 000
In transit.....	290, 000
Total	425, 000
Estimated for July and August, 1883, gross	20, 000
Estimated for July and August, 1883, net.....	9, 000

COTTON EXPORTS OF HOUSTON YEAR ENDING AUGUST 31, 1883.

North and northeast	156, 596
Shipped Gulfward	538, 298
Total cotton shipments.....	694, 894

The number of vessels engaged in the regular trade of Buffalo Bayou are: Steamships, ten; steamers, two; steam tugs and lighters, nineteen; barges, twenty-eight; schooners, twenty; sloops, nineteen.

The number of steamships and sail vessels from ports beyond Galveston navigating Buffalo Bayou and Galveston Bay to Clinton and Houston for the year ending June 30, 1883: Steamships, one hundred and ten; sailing vessels, thirty-four.

TEXAS TRANSPORTATION COMPANY SHIPMENT FROM OCTOBER 1, 1882, TO JUNE 1, 1883.

	Pounds.
Bales cotton, 52,310	26, 961, 866
Bales hides and skins, 1,323	1, 153, 539
Bales and sacks wool, 6,554.....	1, 392, 360
Miscellaneous freight	4, 632, 105

SHIPMENTS BY HOUSTON DIRECT NAVIGATION COMPANY FROM JUNE 1, 1882, TO MAY 31, 1883.

	Pounds.
Cotton, 222,287 bales.....	105, 586, 325
Merchandise.....	6, 406, 391
Salt, 29,719 sacks.....	5, 843, 800
Iron	28, 082, 880
Coal.....	20, 556, 480
Lumber	1, 340, 000
Cotton-seed cake.....	20, 600, 000

There have been shipped through the waters of Buffalo Bayou, by the Houston Direct Navigation Company, from January 1, 1869, to June 30, 1883, 2,227,953 bales cotton.

In addition to vessels arriving at Clinton and Houston in the year ending June 30, 1883, the following vessels were either discharged or loaded by lighters in Galveston Bay or outside the Galveston Bar with cargoes belonging to the direct trade of Houston, and which were unable to enter the waters of Buffalo Bayou on account of the obstruction to navigation in Galveston Bay.

VESSELS LOADED.

	Number.	Tonnage.
Atlantic ports.....	17	8, 890
Foreign ports.....	28	13, 865
Total	45	22, 755

VESSELS DISCHARGED.

Foreign ports.....	12	5, 350
Atlantic ports.....	37	17, 465
Gulf ports.....	31	4, 565
Total	80	27, 380

S. A. MCASHAN,

President Houston Cotton Exchange and Board of Trade.

Maj. S. M. MANSFIELD,
United States Engineers.

P 5.

IMPROVEMENT OF MOUTH OF BRAZOS RIVER, TEXAS.

Estimate for north and south jetties, 1880..... \$522,890 44
 Appropriated, 1880-'83..... 130,000 00

Unappropriated..... 392,890 44

On the 30th of June, 1882, the improvement at this point comprised a partial construction of the north jetty, viz:

First. A layer of brush-mattresses on shore 462½ feet long, 3 feet high, and from 28.7 feet to 60 feet wide, ballasted in part with concrete blocks and having a thorough covering of beach sand.

Second. A seaward portion, extending the foundation courses of jetty 2,073 feet. This course of mattresses had in width of 60 feet, and was 2½ feet in height with the concrete ballast.

Upon the whole this work was then in a good condition; the shore work, although damaged to some extent in appearance, had caused the beach line north of it to extend gulfward, where it maintained itself and gave to the seaward portion of the jetty a good shore bearing.

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1883.

The project for the expenditure of the money (\$50,000) appropriated by act of Congress passed August 2, 1882, was approved. The project covered the following essentials:

If found advisable to raise the north jetty for a short distance near the shore line, then to construct a similar jetty on the south side, giving the work a bent shape, in conformity with the general direction of the channel, to sustain the discharge, regulate its line, and extend the discharge outward to deep water, thereby to obtain beneficial action at an early period of the construction, as advised by the Board of Engineers (page 1355, Report of the Chief of Engineers, 1882). The amount of work recommended was 1,300 feet of foundation and second course of mattresses, or about 2,000 feet of foundation course alone; the outer portion of jetty to be constructed first to stop the movement of the south (west) shoal and to confine the current to a single channel along the natural and shortest line to deep water outside.

An advertisement invited proposals for the work. The following is an abstract of the proposals received:

Abstract of proposals received in response to advertisement dated September 15, 1882, and opened October 12, 1882, for improving mouth of Brazos River, Texas.

No.	Names of bidders.	Brush, 8,000 cubic yards.	Ballast, 3,500 tons.	Aggregate.
		Per yard.	Per ton.	
1	A. M. Shannon & Co	\$2 90	\$6 00	\$44,200
2	Rittenhouse Moore*	3 25	4 50	41,750
3	R. Kanter & Sons.....	3 75	5 00	47,500

* Lowest bidder.

Contract was entered into with Mr. Rittenhouse Moore, October 30; work to commence January 1, and to be completed June 30, 1883.

The first work of this contract was done in March, and covered the placing of four mattresses—415,727 cubic yards of brush-work and 149.2 tons of concrete ballast—in the second course of the north jetty; the work starting from high-water mark and extending Gulfward.

The progress of work under this contract was entirely satisfactory from the beginning, and contract was closed in due time, June 30, as agreed upon. The contract comprised work on both jetties, viz:

North jetty.—The foundation course was extended seaward 300 feet, and a third and fourth course of mattresses added, bringing the crest of the jetty into the plane of mean low water for a distance of 1,493 feet, outward from the shore-line of 1882, thus practically completing this jetty with a total length of 2,433 feet.

South jetty.—The attempt to build this jetty was made and progressed to the extent of laying the foundation course of mattresses a distance of — feet, when it became impossible to proceed to advantage seaward owing to the rapid shoaling of the water. It was thought best to complete the north jetty, and await its effect upon the channel and the ground over which the south jetty is projected, rather than expend our funds to no advantage in building up in deep water, that is likely soon to shoal by natural causes.

The amount of material used was equal to 11,360,506 cubic yards of brush mattresses, and 2,627.7 tons of concrete ballast.

RESULTS OBTAINED.

A considerable improvement has been effected; for the position of the channel and depth of water therein remained quite constant at about 8 feet for nearly the whole year past. This spring, and before the completion of our jetty, a gradual shoaling to about 6 feet took place. The depth is now increasing in consequence of the presence of our jetty, and it is believed when a rise in the river takes place a good deep channel will be cut and a greater depth of water will hereafter be maintained across the bar.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1884.

After the 1st of July the work of improving this entrance ceased for want of funds. No appropriation was made for work at this point at the last session of Congress, and no money is available for expenditure.

Three hundred and ninety-two thousand eight hundred and ninety dollars and forty-four cents is the amount required to complete the improvements here under existing project; of which amount \$100,000 could be profitably expended in the fiscal year ending June 30, 1885, in continuing work on jetties.

This work may not be susceptible of permanent completion; estimates will vary accordingly.

It is located in the collection district of Galveston, and the nearest light-house is at entrance to Galveston Harbor.

The custom-house at Galveston furnishes the following statistics for the year ending June 30, 1883: Vessels entered, 96; tonnage, 1,439.

Money statement.

July 1, 1882, amount available	\$2,240 97
Amount appropriated by act passed August 2, 1882.....	50,000 00
	<hr/> 52,240 97
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	50,730 98
	<hr/> 1,509 99
July 1, 1883, amount available.....	
Amount (estimated) required for completion of existing project.....	392,890 44
Amount that can be profitably expended in fiscal year ending June 30, 1885.	100,000 00

P 6.

IMPROVEMENT OF PASS CAVALLO INLET TO MATAGORDA BAY, TEXAS.

Estimate, south jetty and groins for shore protection, 1879..... \$1,039,280
 Appropriated, 1876-'83 240,000

Unappropriated..... 799,280

The work in place at the close of the last fiscal year (June 30, 1882) was that portion of the south jetty constructed in 1881 and 1882, by the Messrs. R. Kanter & Sons, viz: a total length of jetty of 1,325 feet, consisting of a foundation course averaging 25 to 60 feet width on shore, and full 60 feet width in its seaward portion, and with a second tier and upper course partly built thereon. The condition of the work was excellent.

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1883.

A contract (dated September 19, 1881,) with Mr. G. L. Long, of Mobile, Ala., was in force at the beginning of the year. Work on the south jetty, under the terms of that contract, was commenced on the 5th day of July, and satisfactorily completed by the 18th of September, when final payment was made and contract closed. By this contract the foundation course of the jetty received an extension seaward of 2,250 feet, the width of the course being 60 feet. The material used was in amount equal to 9,820 cubic yards of brush mattresses and 1,801.24 cubic yards of stone ballast.

The project for the expenditure of the funds of appropriation of 1882, passed August 2, \$60,000, recommended work on south jetty, in accordance with the views of the Board of Engineers, by adding thereto a number of brush mattresses well ballasted with stone, the method of construction to consist in extending the foundation-course seaward, raising the jetty to a higher level (if thought necessary) at certain points, by adding above the lower course one or more layers of mattresses, with proportional ballast, and the putting on of stone alone upon the older portion of work, if thought desirable.

The project was approved, and in response to advertisement proposals for doing the work were received, viz:

Abstract of proposals for improving Pass Cavallo, Texas, received in response to advertisement dated September 15, 1882, and opened October 12, 1882.

No.	Names of bidders.	Brush, 10,000 cubic yards.	Ballast, 4,000 tons.	Aggregate.
		Per yard.	Per ton.	
1.	R. Kanter & Sons.....	\$4 75	\$5 00	\$89,500
2.	Rittenhouse Moore.....	5 75	5 75	80,500
3.	A. M. Shannon & Co.*.....	2 90	6 00	53,000

* Lowest bidder.

The contract was awarded to Messrs. A. M. Shannon & Co., of Galveston, Tex., with whom articles of agreement were entered into October 28, 1882; the work to commence December 31, 1882, and to be completed the 30th of June, 1883.

The following is taken from my report of operations for the month of February:

As reported last month, the contractors * * * will not be prepared to enter upon their contract until the work of their contract at Aransas Pass shall be well advanced.

* * Date of commencement is, therefore, indefinite, and will depend altogether upon progress of work at Aransas Pass.

On the 26th of June Messrs. A. M. Shannon & Co. applied for an extension of time for commencing and completing their contract after June 30, 1883. The same has received my favorable indorsement, and has been forwarded for the action of the Department.

The work in place at the close of the year, 3,608 linear feet of south jetty, was, so far as known, in good condition. The condition of the bar remains in its normal state, with a depth of 8 feet of water at mean low tide, but more constant in position. No complaints of any description touching this improvement have been received, and none are expected, for the available water at the entrance is amply sufficient for the present demands of navigation and commerce.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1884.

The contract with Messrs. A. M. Shannon & Co. of October 28, 1882 (extension of time to be granted), covers such work on the south jetty as is considered conducive to a progressive improvement of the pass with the limited amount of available funds therefor. The work of this contract will no doubt take until fall to complete. After its completion, and with the expenditure of the \$60,000 appropriated by act of August 2, 1882, nothing more can be done, no appropriation having been granted for work during the fiscal year 1883-'84.

Two hundred thousand dollars may be profitably expended during the fiscal year ending June 30, 1885, to be applied to jetty work on the south side of the pass, in accordance with approved plan.

The work is located in the collection district of Indianola, Tex., and near Matagorda light-house.

Money statement.

July 1, 1882, amount available	\$5,000 00
Amount appropriated by act passed August 2, 1882.....	60,000 00
	<hr/>
July 1, 1883, outstanding liabilities.....	65,000 00
	<hr/>
July 1, 1883, amount available.....	5,000 00
	<hr/>
Amount (estimated) required for completion of existing project.....	799,280 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	200,000 00

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, INDIANOLA, TEX., *Collector's Office, July 17, 1883.*

DEAR SIR: In response to your letter of 6th instant, I have the honor to inform you that the following is a statement of entrances and clearances of vessels at this port during the fiscal year ended June 30, 1883, viz:

Vessels engaged in foreign trade, entered, steamers 3; 2,995.21 tons.

Vessels engaged in foreign trade, cleared, steamers 3; 2,994.21 tons.

Vessels in coastwise trade, entered, steamers 105; 90,198.88 tons.

Vessels in coastwise trade, entered, sail 3; 415.37 tons.

Total in coastwise trade, entered, 108; 90,614.25 tons.

Vessels in coastwise trade, cleared, sail 6; 642.77 tons.

Vessels in coastwise trade, cleared, steam, none.

The above is but a small proportion of the number of vessels actually visiting this port during the fiscal year. Lumber vessels, as a rule, arriving from the ports they do, are not required, under the law, to enter or clear, hence we have no record in the custom-house of their arrival or departure.

Again, this report shows the entrance of one hundred and five steamers during the year, and no clearances of steamers (coastwise), which is accounted for in this way: their inward cargoes generally consist in part of goods requiring a clearance from the port of departure and entrance at this port, whilst on the return trip the cargo is invariably of domestic goods, requiring no clearance from this office.

I am, very respectfully, your obedient servant,

FRANCIS A. VAUGHAN,
Collector.

Maj. S. M. MANSFIELD, U. S. A.

P 7.

IMPROVEMENT OF ARANSAS PASS AND BAY, UP TO ROCKPORT AND CORPUS CHRISTI, TEXAS.

Estimate for jetties, groins, shore protection, &c., 1879	\$759, 185 00
Estimate for dredging, &c., in the bay, 1879	441, 537 75
	<hr/>
	1, 200, 722 75
Appropriated 1879-'83	280, 000 00
	<hr/>
Unappropriated	920, 722 75

The improvements made at this pass up to June 30, 1882, included the protection of the head of Mustang Island up to and beyond Turtle Cove by means of seven groin jetties built on the west side of the pass, with a breakwater and revetment along the channel face of Mustang Island, the erection of a number of sand-fences on Saint Joseph and Mustang islands to prevent sand drifting into the channel, and the partial construction of a south jetty to sustain the outward currents for effective work upon the bar.

This work consisted of brush mattresses and stone ballast, and was done entirely by hired labor. Materials were obtained partly by contract and partly by purchase in open market. Plant was owned by the Government.

The condition of the work on the 30th of June, 1882, was good.

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1883.

On the 14th of August, a project for the expenditure of the funds (\$100,000) appropriated by act of Congress passed August 2, 1882, was forwarded. In this project I presented—

First. That it should be admitted that the pass was secured from further movement westward, and that the plan of jetty followed pointed to a successful improvement of the bar.

Second. That the good results should be held by extending the jetty work out on the same line, bending it a little to the northeastward in conformity with the natural direction of flow of ebb current, to sustain this current and extend the deep water of the pass outward and over the bar.

Third. That by this plan the two (north and south) channels would be likely to merge into one main channel, and thereby obviate the necessity for a jetty from the Saint Joseph Island shore; and further, that at the same time the pass would be covered from all southeast seas.

Fourth. I therefore recommended the extension of the jetty (about upon the line drawn on the chart forwarded); and stated that we might be able to build 1,000 or 1,500 feet of work and bring it to the level of the low water throughout its length. Also, that perhaps that extent of

work might prove sufficient to secure and maintain for a number of years a depth of 12 to 15 feet of water on the bar.

Finally, that heretofore the work had been done by hired labor, but that it was possible, as well as advisable, then to do the work by contract, and I recommended the invitation of proposals by advertisement in the usual way.

This project was duly approved.

The following is an abstract of proposals received:

Abstract of proposals for improving Aransas Pass and Bay, Texas, received in response to advertisement dated August 21, 1882, and opened September 14, 1882.

No.	Names of bidders.	Brush, 16,000 cubic yards.	Stone, 7,000 tons.	Aggregate.
		<i>Per yard.</i>	<i>Per ton.</i>	
1	Rittenhouse Moore	\$3 50	\$5 25	\$92,750
2	A. M. Shannon & Co.*	2 60	5 60	80,800

* Lowest bidders.

Contract awarded A. M. Shannon & Co.; articles of agreement, dated October 4, 1882, required work to commence November 1, 1882, and to be completed June 30, 1883.

Preliminary operations were begun by the contractors in October. It was found that then the sands had banked against the jetty on the south side to its full length and height as was expected. The work though greatly exposed stood the heaviest seas without damage.

During November and to and including the following February, the contractors were engaged in building ways and platform, cutting brush, getting boats and machinery in order and making other arrangements for their work.

Actual work upon the south jetty commenced March 10, when the contractors succeeded in placing two mattresses (each 30 feet by 95 feet) in the foundation course at the outer end.

From unavoidable causes, owing in a great measure to unfavorable weather, the contractors were unable to complete their work here by the end of June as required. An extension of time (until September 30, 1883), for completing the work has been asked by Messrs. A. M. Shannon & Co., and the same has been forwarded with recommendation that the extension be granted.

At the end of the year (June 30) the contractors, A. M. Shannon & Co., had accomplished the following:

SOUTH JETTY.

Foundation course.—Placed forty-nine mattresses, each 30 feet by 95 feet in plan, and from $1\frac{1}{2}$ to 2 feet in thickness, extending this course Gulfward. Total length of this extension 1,200 feet, 90 feet wide. The work takes a direction bending to the northward, the radius of the curve being 2,880 feet.

Second course.—The mattresses for this course were of various lengths and widths, averaging in thickness $2\frac{1}{2}$ feet, the axis of the course coinciding with the axis of the foundation course below. Total length of this course, 1,083 feet, approximately.

Third course.—This being the top course, the mattresses, each 30 feet by 65 feet with thin ends, were placed across the jetty, breaking joints with the narrow mattresses of the second course below.

Total length for this top course, 911 feet, approximately.



An aggregate of 15,476.44 cubic yards of brush mattresses, together with 3,473.70 tons of stone ballast, were expended in this work by the contractors, for which they received \$59,691.46.

The work has been done to my complete satisfaction.

An examination and survey of the pass and bar in and about the vicinity of the work was made in February and March. A tracing of the same accompanies this report. By comparing this with the chart submitted with my report of last year, it will be observed that our work has been effectual in holding the pass in position and concentrating the flow into a single channel across the bar, much deeper than either of the former channels. The 12-foot curve is out abreast the wreck Mary, and it cannot fail to be apparent to the most casual observer that with the building up of the jetty as contemplated and now in progress 12 feet of water will be carried entirely across.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1884.

The only money available is that of the appropriation of August 2, 1882, a balance of \$36,371.16 remaining unexpended June 30, 1883. With this amount and until its exhaustion work of constructing the south jetty will be continued by Messrs. A. M. Shannon & Co. according to the terms of their contract, extension of time for completing the same to be granted.

No appropriation for this point was made at the last session of Congress for expenditure in the fiscal year 1883-'84. I am advised, however, that \$10,000 has been subscribed by gentlemen largely interested in the development of the section of country adjacent for the continuance of this work, and that it is expected this sum will be doubled, the contractors agreeing to continue the work at the prices of their contract with the Government.

I respectfully renew my recommendation of last year, and advise that \$400,000 could be very profitably expended in the fiscal year ending June 30, 1885, in constructing jetties at the pass and improving the interior channels.

The work is located in the collection district of Corpus Christi, and the nearest light-house at Aransas Pass.

Money statement.

July 1, 1882, amount available	\$448 53
Amount appropriated by act passed August 2, 1882	100,000 00
	<hr/> 100,448 53
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$62,021 61
July 1, 1883, outstanding liabilities	36,371 16
	<hr/> 98,392 77
July 1, 1883, amount available	<hr/> 2,055 76
Amount (estimated) required for completion of existing project	920,722 75
Amount that can be profitably expended in fiscal year ending June 30, 1885.	400,000 00

COMMERCIAL STATISTICS.

Col. Nelson Plato, collector of customs at Corpus Christi, furnishes me the following statement of tonnage for this port *via* Aransas Pass, for the fiscal year ending June 30, 1883:

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VESSELS IN FOREIGN TRADE.

	<i>Entered.</i>	<i>Tonnage.</i>
7 sail		2,151
15 steamships		26,285
Total		28,436

	<i>Cleared.</i>	
3 sail		804
4 steamships		5,515
Total		6,319

VESSELS IN COASTWISE TRADE.

	<i>Entered.</i>	<i>Tonnage.</i>
5 sail		728
51 steamships		54,344
Total		55,072

	<i>Cleared.</i>	
10 sail		2,223
60 steamships		71,097
Total		73,320

In addition to the foregoing there were two hundred and sixty-six vessels engaged in the domestic trade that entered and cleared here outside the custom-house, with an aggregate tonnage of 12,558 tons. This latter class of vessels were largely engaged in the lumber trade.

LETTER OF THE COLEMAN FULTON PASTURE COMPANY.

OFFICE OF THE COLEMAN FULTON PASTURE COMPANY,
Rockport, Tex., July 19, 1883.

DEAR SIR: Annexed please find statement of, and business done, over our wharf for the year ending June 30, 1883.

Cattle shipped	head..	3,121
Freight received and shipped	barrels..	71,970
Cotton shipped	bales..	335
Wool shipped	bags..	88

Yours truly,

COLEMAN FULTON PASTURE COMPANY.
SAML. J. SEYMORE.

N. B.—Since January, 1883, the shipments of cattle have been transferred to railroad.

Col. S. M. MANSFIELD,
Major, Corps of Engineers.

P 8.

IMPROVEMENT OF HARBOR AT BRAZOS SANTIAGO, TEXAS.

Estimate for jetties and interior dam, 1881	\$678,084 50
Appropriated 1880-'83	160,000 00
Unappropriated	518,084 50

*Appropriation of 1878, \$6,000, was applied to removing a wreck; is not included in above total amount.

On the 30th of June, 1882, the work in place at this point covered a beach layer of mattress work 60 feet wide, 495 feet long, and, with the brick ballast, 2½ feet high above the sand bottom. This work was then in excellent condition.

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1883.

The contract of January 2, 1882, with Mr. G. L. Long was in force at the beginning of the year, and up to the middle of July the contractor's work progressed satisfactorily. About that time yellow fever became epidemic in that section. This was unfortunate for Mr. Long, and doubly so when, in August, Mr. Winston, his superintendent at that point, died with that disease. The United States inspector, Mr. J. C. Wright, was taken down with the fever in the same month, but recovered in time to do good service when most needed.

During August, September, and October the work was run at a great disadvantage, with a disorganized force, and in the face of a restricted quarantine. The difficulties which had to be overcome were such as forced the contractor to suspend his work the latter part of November. In order to relieve the contractor he was, upon his request, granted an extension of time (to June 30, 1883) in which to complete his contract.

In May, Mr. Long resumed operations on south jetty, and up to June 30, under his contract, he had accomplished the following work:

1. *Foundation course.*—Commencing at a point on the Brazos Island beach at high-water mark, an extension of brush-mattress work 2,295 feet, of which 2,200 feet was 60 feet wide, and 95 feet, 90 feet wide. The mattresses used were, as a rule, 30 feet by 90 feet in plan, and had an average thickness of 1.8 feet.

2. *Second course.*—Beginning at a point 930 feet from shore end of the work, mattresses 30 feet by 90 feet were laid along the axis of the lower course, raising the jetty for a length of 720 feet.

During the year the contractor expended in the work 9,133,339 cubic yards of brush-mattresses, and 2,114.18 tons of brick ballast, receiving therefor \$44,152.82. The work has been done most satisfactorily, and its condition is good.

An examination at the close of June showed the work is in satisfactory progress. With the expenditure of available funds this south jetty will be quite completed; and we may reasonably expect, as a result, a greatly improved channel of entrance.

The report of Inspector Wright is here inserted as detailing more particularly the character of the work:

LETTER OF MR. J. C. WRIGHT, UNITED STATES INSPECTOR.

BRAZOS ISLAND, TEXAS, July 1, 1883.

SIR: In accordance with instructions from you by letter of June 12, 1883, "to submit a report of condition of jetty, character of brush and ballast, depth of water on the bar, and any change in the pass caused by the jetty," I submit the following: In laying a second course of mattresses on the south jetty I had a very good opportunity to examine the foundation course. I found it, as far as I laid the second course, a distance of 720 feet, in very good condition; the mattresses on the south side being well covered and filled in with sand, while the north mattress, although filled with sand, was not covered. The shore line, both on the north and south sides, has followed the jetty out for a distance of 500 or 600 feet; and the jetty for that distance from its starting point is entirely covered with sand and is out of sight. The channel after leaving the pass runs parallel to, until it reaches the end of, the jetty as it stood when left last year. After reaching the end the channel takes a sharp turn and runs parallel to the beach until opposite the life-saving station, where it then turns towards the buoy. Where the mattresses were placed this year there is an average depth of 13½ feet of water and 10 to 10½ feet on top. The change of the channel is,

I think, due to the northerly winds during winter forcing the current running out of the pass against the jetty, which held it until it got to the end, and then cut this deep channel around the end. The depth of water on the bar at high tide is about 12 feet, while at the same tide there is about 10½ feet on top of the mattresses in the channel. On line of the south jetty across the north breaker, or bar, there is about 6 feet of water at high tide; about four or five 90-foot mattresses in length will carry us onto this breaker. The increase in depth of water is, I think, due to the jetty, together with the strong currents running in and out of the pass; the current running, while tide is ebbing, at least 4 miles per hour. This, I think, is caused by Boca Chica being dry now and the water having only one outlet. Another thing that may be considered as an important factor is the narrowing of the pass between Brazos Island and Padre Island, the northeast point of Brazos Island having made out considerably.

The brush used is willow, mesquite, crasillo, and sinesa; the two latter are not used very much. The fascines are made entirely of willow and mesquite, and are very strong and good.

The ballast used is brick, weighing about 12 pounds apiece. The brick made at Point Isabel are of a dry clay, which is mixed with water, placed in moulds to dry, and then burnt eight days in a kiln. The ballast is, I think, rather light for this work. I started a second course on the south jetty to determine whether the ballast would answer. Up to the 27th of June we had no bad weather, and the last mattress placed on the second course commenced to break up the morning of the 26th. This mattress was placed in 10 feet of water, and had 7 feet on top of it. I only placed 40 tons on it, as more than that is useless, as the sea washes it right off.

Very respectfully, your obedient servant,

J. C. WRIGHT,
U. S. Inspector.

Major S. M. MANSFIELD,
Corps of Engineers, U. S. A.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1884.

On the 19th of June Mr. Long requested a further extension of time (to September 30, 1883) in which to complete the work under his contract of January 2, 1882. The request received my favorable indorsement, and was approved by the Chief of Engineers on June 28.

On the 30th of June there remained to the credit of this improvement \$41,196.09 of the appropriations of 1880 and 1881, and \$60,000 of the appropriation of 1882.

The contact with Mr. Long will exhaust the money of the older appropriations on or before the 30th of September, by which time it is expected that a contract (under appropriation of \$60,000) will have been entered into, when work will continue without interruption. The work will be concentrated upon the south jetty to its entire completion.

Two hundred thousand dollars could be profitably expended at this point in the fiscal year ending June 30, 1885, in continuing the work of improvement originally estimated for.

It is located in the collection district of Brownsville, Tex., and the nearest light is Brazos Island light-beacon.

Money statement.

July 1, 1882, amount available.....	\$3,210 75
Amount appropriated by act passed August 2, 1882.....	60,000 00
	<hr/> 63,210 75
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$3,060 75
July 1, 1883, outstanding liabilities.....	150 00
	<hr/> 3,210 75
July 1, 1883, amount available.....	60,000 00
Amount (estimated) required for completion of existing project.....	518,084 50
Amount that can be profitably expended in fiscal year ending June 30, 1885.	200,000 00

P 9.

PROTECTION OF RIVER BANK AT FORT BROWN, TEXAS.

First appropriation (1876).....	\$10,000 00
Second appropriation (1879).....	7,000 00
Third appropriation (1882).....	1,000 00
Total	18,000 00
Amount expended to June 30, 1883.....	16,769 96
Amount available to June 30, 1883	1,230 04

It was stated in last year's report that the results attained at this point were not commensurate with the expenditure; therefore it was considered best not to attempt to control the Rio Grande at this place by artificial works, it being considered more expedient to move, from time to time, such of the buildings as should be in actual danger.

No further appropriation for this work was recommended.

I made a personal examination of this river bank in April last. It appeared to be in much better condition than I had been led to expect. The brush revetment above water seems to have slid down the bank into the river and formed an excellent protection against the bank being undermined by the currents. At the time of my examination the water was at about its normal level, and a wide solid berme existed just above this level, while the bank above was, to a great extent, well sodded.

No serious encroachment upon the land had occurred, and upon the whole the condition of the river bank in this locality was much more stable than three years ago, when I saw it.

No further appropriation is recommended.

Money statement.

July 1, 1872, amount available	\$230 04
Amount appropriated by act passed August 2, 1882	1,000 00
	<hr/>
	1,230 04
	<hr/>
July 1, 1883, amount available.....	1,230 04

APPENDIX Q.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, AND OF VARIOUS WATER-COURSES IN LOUISIANA.

REPORT OF MAJOR AMOS STICKNEY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|--|---|
| 1. Pearl River from Jackson to Carthage, Miss. | 9. Connecting Bayou Teche with Grand Lake at Charenton, La. |
| 2. Pearl River below Jackson, Miss. | 10. Bayou Black, Louisiana. |
| 3. Amite River, Louisiana. | 11. Bayou Courtableau, Louisiana. |
| 4. Vermillion River, Louisiana. | 12. Bayou Terrebonne, Louisiana. |
| 5. Tangipahoa River, Louisiana. | 13. Bayou La Fourche, Louisiana. |
| 6. Techefuncte River, Louisiana. | 14. Calcasieu River, Louisiana. |
| 7. Tickfaw River, Louisiana. | 15. Calcasieu Pass, Louisiana. |
| 8. Bayou Teche, Louisiana. | 16. Removal of wreck in Pass Marianne, Mississippi Sound. |

EXAMINATIONS AND SURVEYS.

- | | |
|----------------------------------|------------------------------------|
| 17. West Pearl River, Louisiana. | 19. Bogue Chitto River, Louisiana. |
| 18. Grand Lake, Louisiana. | |

UNITED STATES ENGINEER OFFICE,
New Orleans, La., July 30, 1883.

GENERAL: I have the honor to forward herewith my annual reports for the fiscal year ending June 30, 1883, for the works of improvement in my charge.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

Q 1.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, FROM JACKSON TO CARTHAGE.

The total amount appropriated for this work is \$18,500. Contract was entered into with J. S. Hamilton & Co. November 20, 1879, for improving some of the worst reaches of the river between Jackson and Carthage, and on October 12, 1880, another contract was made with J. S. Hamilton for improving 51 miles of the river up-stream from Jackson.

These two contracts covered the amounts appropriated March 3, 1879, \$6,000, and June 14, 1880, \$7,500. An appropriation of \$2,500 was made March 3, 1881, but after due advertisement no bids were received for

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work under this appropriation, and the amount was allowed to stand awaiting further appropriation sufficient to warrant commencement of work. August 2, 1882, an additional appropriation of \$2,500 was made, and on the 17th of August, 1882, a project was submitted to continue the work by hired labor, which was approved. In the mean time work under the Hamilton contracts did not progress; various excuses were made; then the work was reported completed. An assistant engineer inspected it, and, having reported to the effect that its condition was if anything worse than when the original survey was made, the contracts were annulled on the 22d September, 1882. The whole amount, therefore, of the various appropriations, less some necessary expenses, is now available for the work, and on June 16, 1883, I submitted a proposition to the Department to construct the necessary plant to consist of a steam derrick-boat and a quarter-boat, and have the work done by hired labor. This meeting the approval of the Department, the work will be commenced during this season, and it is hoped that some satisfactory results may be reported next year.

This work originated from an examination provided for by Congress in the river and harbor act of 1878, a report of which, with plan and estimate of cost of improvement, was published in the Report of the Chief of Engineers for 1879, Appendix K 2.

The work is not considered permanent, as the obstructions caused by logs, snags, and drift are liable to reform at any time, owing to caving banks carrying trees, &c., into the stream.

COMMERCIAL STATISTICS.

Considerable business is done by the merchants of Carthage and Edinburgh, who have to haul their supplies some 20 or more miles from the Illinois Central Railroad at Canton, Mis., over very bad roads for the greater portion of the year, and the products of the country, principally cotton, have to seek the same outlet. There is no doubt but that the improvement of said river would tend to build up that country. The commerce of the river consists in transportation of cotton and flour, salt, and general merchandise. It has been costing consumers \$2 for flour and salt by wagons to Edinburgh, and the boats delivered it for 60 cents, which is a saving of \$1.40 per sack or barrel just for transportation. The lands contiguous to the stream have very large quantities of very valuable timber, consisting principally of white oak and cypress, for staves and shingles, which are in great demand in New Orleans and other principal cities. A company at Edinburgh has already one boat on the river, and could have another if necessary.

The work is located in the collection district of New Orleans, and the nearest light-house is on the Rigolets opposite the mouth of West Pearl River.

Original estimate	\$21,000 00
Total amount appropriated	18,500 00
Total amount expended	699 24

Money statement.

July 1, 1882, amount available	\$15,398 34
Amount appropriated by act passed August 2, 1882	2,500 00
	<hr/>
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	17,898 34
	97 58
	<hr/>
July 1, 1883, amount available	17,806 76
	<hr/>
Amount (estimated) required for completion of existing project	2,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	2,500 00

Q 2.

IMPROVEMENT OF PEARL RIVER BELOW JACKSON, MISSISSIPPI.

The project for the improvement of this river was adopted in 1880, the object being to obtain a navigable channel 5 feet deep at low water from Jackson down to the mouth of the river. The principal work necessary to accomplish this was the removal of snags, sunken logs, rafts, standing trees in the water, and overhanging trees, and the closing of run-out bayous.

An appropriation of \$30,000 was made for the commencement of the work June 14, 1880, and under this appropriation a contract was made with Seth N. Kimball for clearing 195 miles of the river, commencing at Jackson. The work was to have been finished January 1, 1882. Two extensions of the contract time were granted, the last calling for completion of work January 1, 1883. On December 1, 1882, Mr. Kimball reported his work finished, and demanded an inspection. The water was so high, however, that no inspection could be made, and none has been made yet since December 1, 1882. Inspection made previously showed that the greater portion of the work had been done, and as it was deemed unjust to the contractor to keep him waiting for his payment until the low water of summer, the Department, in letter of January 17, 1883, directed me to make a supplemental contract with Mr. Kimball in regard to terms of payment. This supplemental contract was accordingly made January 23, 1883, and under its terms Mr. Kimball was paid \$25,000, the remainder of the contract price, \$3,736, to be held until a low-water inspection should show the work completed.

March 3, 1881, \$25,000 was appropriated for the work and a contract was made with Gustavus A. Meyer, for clearing 100 miles of river, commencing at a point 195 miles from Jackson, the end of Kimball's work.

On July 27, 1882, the work was reported finished, but an inspection showed that it was not in accordance with specifications, and the contractor resumed work. Having again reported it finished an inspection was made, and the inspector on August 23, 1882, certified that it was completed in accordance with specifications, and the work was accepted. Thus \$53,736 has been applied to the clearing out of 295 miles of river, but there still remains from 15 to 20 miles near the mouth a considerable portion of which is in such bad condition that it is almost entirely closed to navigation, and beside this there are a number of shoal places on the reaches under contract, the improvement of which was not included in the contracts further than the removal of snags, trees, &c. August 2, 1882, a further appropriation of \$15,000 was made for this work, and this is being expended under the supervision of this office by hired labor. The work is being directed to the closing of run-out bayous which carry off a great deal of water and cause shoals between the head of West Pearl and the foot of Home bayous. When these run-outs have been closed and the water entirely confined to the river bed on this reach, it is intended to complete the cleaning-out process to the mouth, and after that to take up the other shoal places in order, provided Congress furnishes the means.

The Pearl River should be a good navigable stream at all seasons of the year, and I am informed by parties in New Orleans that they will place steamboats upon it for regular trips as soon as safe navigation is assured. The work done under the contracts was from its nature not of a permanent character, for snags and logs and growing trees will

continue to become obstructions, and it is very probable that there are still remaining such obstructions which could not be detected at the time of inspection, but the river worked over is undoubtedly in such condition that some years must elapse before it can fill up again, and a working party with proper appliances can keep it clear. There is, however, one serious trouble to be met, and that is the action of the lumbermen who run loose logs on the river in such large quantities at times as to fill the entire channel. This must be stopped by the strong hand of the law. The amount of the original estimate not yet appropriated is \$25,940. I cannot say that this will complete the work, but its expenditure will certainly go far toward putting the river in navigable condition and make useful the work already done.

This work originated in an examination authorized by act of Congress, approved June 18, 1878, a report of which, together with plan and estimate of cost of improvement, was published in Report of the Chief of Engineers for 1879, Appendix K 2.

The improvement is not considered a permanent one, as the obstructions caused by trees, logs, and snags are liable to reform at each high water, so that the services of a snag-boat will probably be required for some time of each year to keep the channel clear.

COMMERCIAL STATISTICS.

There have been brought out of Pearl River this winter and spring by steamboat and flat-boat about 2,000 bales of cotton, valued at \$90,000; 50,000 saw-logs, valued at \$112,500, and an unknown quantity of rice. It is expected that, with a navigable river for all seasons of the year, commerce will be benefited to a great extent, as transportation by steamboat is cheaper by one-half. In consequence of the leaning timber being cut away and some of the outlets stopped, there is deeper water and a better current in the part of the river known as the Shoals.

The gentleman who furnished me with the above information states that he is building a steamboat with capacity of 1,000 bales of cotton, which he proposes running as far up as Jackson, and even above.

The merchants along the river propose building warehouses for convenience of steamboating, as they much prefer shipping by steamboat.

The work is located in the collection district of New Orleans. The nearest light-house is at the Rigolets opposite the mouth of West Pearl River.

Original estimate.....	\$95,940 00
Total amount appropriated.....	70,000 00
Total amount expended.....	60,543 49

Money statement.

July 1, 1882, amount available.....	\$52,924 92
Amount appropriated by act passed August 2, 1882.....	15,000 00
	<hr/>
	67,924 92
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$57,239 99
July 1, 1883, outstanding liabilities.....	1,223 42
	<hr/>
	58,468 41
July 1, 1883, amount available.....	9,456 51
	<hr/>
Amount (estimated) required for completion of existing project.....	25,940 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	25,940 00

Q 3.

IMPROVEMENT OF AMITE RIVER, LOUISIANA.

By act of Congress, approved June 14, 1880, \$8,000 were appropriated for the commencement of this work, and a contract was made with H. E. Glasscock covering the first 40 miles of river above the junction of Bayou Manchac. The contract called for the completion of the work as soon as possible, but owing to high water and inefficiency of the contractor the work dragged along till August 22, 1882, when it was reported completed.

An inspection showed that it was not completed, and the contractor was informed that if he did not immediately prosecute the work with proper diligence, the contract would be annulled. This had the desired effect and work was continued with some show of energy, but was considerably delayed by the state of water. Upon March 15, 1883, an inspector reported it finished. March 3, 1881, an additional appropriation of \$5,000 was made for continuing the work. Advertisements for proposals failed to elicit any bids. Afterwards two bids were received informally, and that of W. G. Mitchell was accepted and contract signed October 17, 1881, but Mr. Mitchell persistently failed to furnish bonds. Finally the contract was set aside and the work again advertised.

Proposals were opened August 9, 1882. The following is an abstract of the bids:

Abstract of proposals received in response to advertisement dated July 7, 1882, and opened August 9, 1882, by Amos Stickney, Major, Corps of Engineers, for improving Amite River, Louisiana.

No.	Names of bidders.	Amount per mile for removal of obstructions.	Date of commencement.
1	John Maguire	\$399 00	Not stated.
2	J. H. Gardner	247 00	Within 60 days from date of signing contract.
3	Carl P. Seymer	For 5 miles 350 00 For each mile above the first 5 450 00	Not stated.
4	G. A. Myer	287 50	Do.
5	Ed. H. Farquhar	450 00	Do.

J. H. Gardner was the lowest bidder, and it was recommended that his bid be accepted, which was approved. In the mean time Gardner was superintending the improvement of the Pearl River under the contract of S. N. Kimball, and stated that he expected to start work on the Amite after the completion of the Pearl. The unsatisfactory progress on the Pearl River, together with complaints from the Amite concerning progress under Glasscock's contract, led me to the conclusion that this class of work could be better done under the system of hired labor, and I therefore, on August 24, 1883, recommended suspension of action in awarding the contract. Further action was delayed until it could be known whether it would be necessary to annul Glasscock's contract. As his work showed more energy under a new superintendent, it was deemed best not to interfere with it. The work having been placed under the supervision of my assistant, Capt. D. W. Lockwood, Corps of Engineers, United States Army, he was directed to take steps for the further prosecution of the work.

The following communication was received from him :

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 25, 1883.

SIR: I would respectfully call your attention to the following, with reference to the improvement of the Amite River, Louisiana. The contract now in force with H. E. Glasscock provides for the improvement of 40 miles of the river up-stream from its junction with Bayou Manchac. This work is being done under the appropriation of June 14, 1880. When the original project for improving the river was made by Major Howell in 1880 the mouth of Bayou Manchac was taken in Lake Maurepas, and that of the Amite in the bayou, 36½ miles from the lake, or, in other words, the Amite was assumed to empty into the bayou. This is shown conclusively by Major Howell's letter to the Chief of Engineers, forwarding abstract of bids, under date of September 7, 1880. When the appropriation of March 3, 1881, was made the project submitted for its application was to extend the improvement up-stream from the termination of Glasscock's work. W. G. Mitchell, the lowest bidder at the first letting for continuing the work under this appropriation, failed to furnish the necessary bonds required by the contract, and new proposals were opened August 9, 1882. That of J. H. Gardner, being the lowest, was recommended for acceptance, and was approved by the Chief of Engineers. Afterwards, under date of August 31, 1882, the Chief of Engineers suspended action under the authority previously granted for entering into contract with Mr. Gardner, and thus the matter stands at present. In my opinion, a mistake was made in the original project in the location of the mouth of the Amite, as Humphreys and Abbot, in their report on the Mississippi River, page 421, refer to Bayou Manchac as "a former outlet" [of the Mississippi] "to the Amite River." The mouth of the Amite has always been regarded as in Lake Maurepas by the people in that section, so that I have no doubt but that when the original appropriation was made the intention was to improve the channel from the lake up-stream. The present contractor, Mr. Glasscock, has found considerable difficulty in getting his plant, of light draught, to the upper limit of his work, and the assistant engineer, who made the original examination of the river in 1879, refers to the general character of the upper portion of it as "a succession of pools, connected by ripples or shoals, thereafter being not more than 1 foot of water over them." Besides, the bed of the stream is divided up into small channels by islands. The bars or shoals are composed of gravel, and would in all probability have to be deepened by dredging. At the very best, supposing all reasonable improvements made, the navigation of this portion of the river would only be possible for a few months in the year, that is, during high water. The portion of the river between Lake Maurepas and the mouth of Bayou Manchac, 36½ miles, is more or less obstructed by snags, sunken logs, and overhanging trees, and assistant engineer Buchanan estimates that their removal will cost \$2,718.75. I would respectfully suggest that the money now available for the improvement of this river, or as much of it as may be required for the purpose, be applied to clearing the lower river below the Manchac, and that the work be done by hired labor, &c., in connection with continuing the improvement of Tickfaw and Tchefuncte rivers, the cost of plant, &c., to be borne by the appropriations for these three streams in proportion to their amounts. The amounts available for these works are approximately as follows:

Amite River, balance of appropriation of 1881	\$4,800
Tickfaw River, balance of appropriation of 1882	1,997
Tchefuncte River, balance of appropriation of 1881, and appropriation of 1882	2,450

These works are near each other, and I think that by using a single outfit a more economical application of the amounts available for their improvement will be secured than by letting any or all of them at contract, particularly as these amounts are comparatively small. In connection with what has been said regarding the Amite, there is appended to this a copy of communication received at this office December 28, 1882, from owners of steamers employed in the Amite trade.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Captain of Engineers.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

This was forwarded to the Department with the following letter:

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 27, 1883.

GENERAL: I have the honor to transmit herewith a communication from Capt. D. W. Lockwood, Corps of Engineers, United States Army, relating to the expenditure of the appropriations for continuing the improvements of the Amite, Tickfaw, and Tchefuncte rivers, La.

The award of contract to J. H. Gardner, for continuing work on the upper part of the Amite River, was suspended on my recommendation. The award of contract to G. A. Meyer, on Tickfaw River, has not yet been carried into effect on account of said Meyer's difficulties in levee work. Two of his levee contracts have been annulled, and I do not think it advisable to make any new contracts with him, at least at this time. Nothing has yet been done with regard to starting work on the Tchefuncte River. I fully concur in the recommendations of Captain Lockwood that work on the Amite River should commence at Lake Maurepas. My predecessor, the late Major Howell, considered the Amite River a tributary of Bayou Manchac, and projects for its improvement were made accordingly, but as far as I can learn the stream that flows into the lake is known as the Amite, and as that is the most navigated, I think there is little doubt that the appropriation was intended as much for that part as any other. I am also well satisfied that the carrying on of the work by hired labor with a plant to be used on the three streams, Amite, Tickfaw, and Tchefuncte, will result in much more satisfactory work and more of it than could possibly be procured by contracts. I have therefore to request authority to reject the bids on Amite and Tickfaw rivers, and to proceed in accordance with Captain Lockwood's recommendations with the work on the three rivers, Amite, Tickfaw, and Tchefuncte, the latter to be examined before commencement of work in accordance with project submitted in my letter of August 17, 1882.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

In letter of February 3, 1883, the Department approved the project of procuring a plant and prosecuting the work of improvement of the Amite, Tickfaw, and Tchefuncte rivers by hired labor, but suggested the advisability of hiring a plant instead of constructing or purchasing. Upon inquiry, however, no plant just suited to the work was found, and that which came nearest to requirements was held at figures that showed the interests of the works would be better served by the construction of suitable working boats, and in letter of June 20, 1883, the Department approved of my recommendation to construct or purchase the necessary plant. This will be done and work commenced as soon as possible. No appropriation is asked for fiscal year ending June 30, 1885. This work originated in an examination authorized by act of Congress approved March 3, 1879, a report of which, together with plan and estimate of cost of improvement, was published in Report of Chief of Engineers for 1880, Appendix M. The improvement is not considered a permanent one, as the obstructions are liable to reform.

COMMERCIAL STATISTICS. •

The value of the commerce of this river in 1879 was estimated to be about \$250,000. The work done under contract has not been of any apparent benefit. The continuation of this character of work by hired labor will no doubt render navigation of the lower river safe for schooners engaged in carrying the various products to New Orleans to market. Staves, shingles, lumber, and wood, and a considerable quantity of sugar and molasses are the principal products of the lower portion of the stream.

The work is located in the collection district of New Orleans, and the nearest light-house is at the mouth of Pass Manchac.

Original estimate.....	\$23,761 00
Total amount appropriated.....	13,000 00
Total amount expended.....	8,466 90

5455—E 83—70

Money statement.

July 1, 1882, amount available	\$12,697 74
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	8,164 64
July 1, 1883, amount available	4,533 10
Amount (estimated) required for completion of existing project	10,760 00

Q 4.

IMPROVEMENT OF VERMILLION RIVER, LOUISIANA.

The total amount appropriated for this river, \$9,900, with the addition of \$253.32 from appropriation for examinations, surveys, and contingencies of rivers and harbors, has been expended, and the improvement completed about as projected, with exception of closure of eastern entrance to cove. The first appropriation of \$5,000, in act of Congress approved June 14, 1880, was expended in contract work, during the summer of 1881, in cleaning out 22 miles of river from the railroad bridge above Vermillion down stream. The second appropriation of \$4,900, made in act of March 3, 1881, was expended during the past season in cleaning out the river to the mouth from the point where the work ended under the first contract, a distance of 27½ miles, and the construction of a brush dike, 650 feet long, to partially close the eastern entrance to the cove, through which Vermillion River runs to reach the bay.

The amount of \$253.32, allotted from the appropriation for contingencies, was necessary to pay the expenses of inspection, which were larger than anticipated, owing to the delay of the contractor in finishing the dike, and the necessity of inspecting a part of the river a second time, the first inspection showing the work incomplete.

It was supposed at the time the contract was made by my predecessor that 650 feet of dam would entirely close the eastern entrance, but when I sent an engineer to locate the dam it was found that it would require 1,800 feet. The 650 feet of dam contracted for was therefore thrown out as a dike or jetty.

It may be found necessary to continue this jetty to the island, so as to entirely close the eastern entrance, but before recommending any further expenditure at this point, I would deem it proper to await results from work already done. If the brush dam is sufficiently permanent, and the current due to flow and ebb of tide is sufficient to deepen the channel, the continuation of the work might be recommended.

COMMERCIAL STATISTICS.

The following statistics, giving products of Vermillion Parish, were furnished by the district clerk. He states that almost all of the products enumerated below are shipped down the Vermillion River in consequence of boggy roads leading to the railroad; that real estate has increased 100 per cent. within the last two years, and steamboatmen

say that the commerce of the river has increased 200 per cent. within the last year.

Products.	Shipped in 1870.		Shipped in 1882.	
	Number.	Value.	Number.	Value.
Sugar.....hogsheads	398	\$23,880	3,071	\$182,100
Molasses.....barrels	597	8,955	5,480	82,250
Rice.....do	941	3,780	3,900	15,600
Cotton.....bales	545	27,250	3,022	153,000
		63,865		433,610

This work originated in an examination authorized by act of Congress approved March 3, 1879, a report of which, together with plan and estimate for improvement, was published in the Report of Chief of Engineers for 1880, Appendix M 12.

The improvement is not considered of a permanent character, except so far as the dike at the mouth of the river is concerned, because the obstructions in the stream are liable to reform at any time.

The work is situated in the collection district of New Orleans, and the nearest lighthouse is at the entrance of Atchafalaya Bay.

Original estimate	\$9,900 00
Total amount appropriated, and allotted.....	10,153 32
Total amount expended.....	10,153 32

Money statement.

July 1, 1882, amount available	\$4,727 68
Amount allotted from appropriations for "examinations, surveys, and contingencies of rivers and harbors".....	253 32
	<u>4,981 00</u>
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	4,981 00

Q 5.

IMPROVEMENT OF TANGIPAHOA RIVER, LOUISIANA.

By act of Congress approved March 3, 1881, an appropriation \$2,000 was made for continuing the improvement of this river.

A project for its expenditure having been approved by the Chief of Engineers the work was duly advertised. Only one bid was received and opened July 30, 1881. This bid was by Carl P. Seymer, who proposed to improve 6 miles of river for \$2,000. This being considered excessive the bid was rejected and the money held to await further appropriations. In the river and harbor act of August 2, 1882, no appropriation was made for this work. The work was therefore again advertised, and bids opened October 12, 1882.

1108 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

The following is an abstract of the bids:

Abstract of proposals received in response to advertisement dated September 11, 1882, and opened October 12, 1882, by Amos Stickney, Major, Corps of Engineers, for improving Tangipahoa River, Louisiana.

No.	Names of bidders.	Amount per mile for removal of obstructions.	Date of commencement.
1	C. E. Cate.....	\$235	As soon as season will allow.
2	G. A. Meyer.....	400	
3	John Maguire.....	244	
			Within six months, and finish within twelve months, condition of the river permitting.

* Received after time set for opening proposals. Held at the post-office for non-payment of postage, the postage having been insufficient.

C. E. Cate being the lowest responsible bidder, the contract was awarded him, and articles of agreement entered into January 3, 1883, for the clearing out of $7\frac{1}{2}$ miles of river, beginning at a point 34 miles from the mouth, where work under the last contract ended. Owing to high water the work was not commenced until about the first of June. No official information has been received concerning progress. Payment is to be made on completion of work. The improvement is not considered permanent, as the obstructions caused by trees, logs, snags, &c., are liable to reform.

The original estimate of cost for improvement of $53\frac{1}{2}$ miles of river was \$10,700.

The amount appropriated to date is \$7,000, which, with the work now under contract, will carry the improvement to a distance of $41\frac{1}{2}$ miles from the mouth. It is recommended that the remaining \$3,700 be appropriated to complete the work as originally estimated.

This work originated in an examination authorized by act of Congress approved June 18, 1878, a report of which, together with plan and estimate for improvement, was published in the Report of the Chief of Engineers for 1879, Appendix K 14.

COMMERCIAL STATISTICS.

The value of the commerce of this river has not been ascertained, but since the first work of improvement was made it is said to have increased fourfold. There have been four saw-mills erected within the limits of the survey since the first 34 miles were improved. From the 34th mile up stream, including the portion now under contract, are to be found the finest timber lands in this section, which can only be made available by putting the river in condition for an outlet. The commerce at present is mostly transporting lumber and timber and saw-logs, with some wood, charcoal, and tar.

The work is situated in the collection district of New Orleans. The nearest light-house is at the mouth of Pass Manchac.

Original estimate.....	\$10,700 00
Total amount appropriated.....	7,000 00
Total amount expended.....	5,016 25

Money statement.

July 1, 1882, amount available.....	\$1,991 01
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	7 26
July 1, 1883, amount available.....	1,983 75
Amount (estimated) required for completion of existing project.....	3,700 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	3,700 00

Q 6.

IMPROVEMENT OF TCHEFUNCTE RIVER, LOUISIANA.

By act of Congress passed August 2, 1882, an appropriation of \$1,500 was made for continuing the improvement of this river, which with the amount unexpended, remaining from the previous appropriation, made an amount of \$2,542.24 available for the work. The project for the expenditure of this as approved in Department letter of February 3, 1883, is to have the work done in connection with the improvement of the Amite and Tickfaw rivers, the same plant being used for all.

Before any work is done, however, an examination will be made to ascertain as to the propriety of continuing the work upon the original plan, which included dredging at the mouth.

It is possible that a jetty without dredging will be sufficient to deepen the channel over the bar and keep it from filling. In all events a jetty would seem to be required if greater depth is to be carried over the bar. I recommend that the sum of \$2,460, or the balance to complete original estimate, be appropriated for fiscal year ending June 30, 1885.

This work originated in an examination authorized by act of Congress approved March 3, 1879, a report of which, together with plan and estimate of cost, was published in the Report of the Chief of Engineers for 1880, Appendix M. The improvement is not considered a permanent one, as the obstructions are liable to reform.

COMMERCIAL STATISTICS.

There are twenty-five schooners constantly engaged in carrying sand, brick, wood, charcoal, and lumber to the city of New Orleans from the Tchefuncte River, making from four to five trips a month, and varying from 15 to 35 tons each.

The amount annually shipped is as follows:

Brick, 4,000,000	\$40,000
Sand, 60,000 barrels	12,000
Wool, 30,000 pounds	9,000
Wood, 400 cords	12,000
Charcoal, 50,000 barrels	10,000
Cotton, 2,500 bales	
Lumber, 500,000 feet	6,000
Sugar, 20 hogsheads	1,400
Sirup, 200 barrels	3,200
Hewed timber, 30,000	1,350
Beef, 1,000 head	10,000
Hides, 500	1,500
Total	106,450

This trade could be largely increased in brick, sand, lumber, wood, and coal, if the demand in the city of New Orleans required it.

The work is located in the collection district of New Orleans. The nearest light-house is near Madisonville on the river.

Original estimate	\$5,460 00
Total amount appropriated	3,000 00
Total amount expended	545 76

Money statement.

July 1, 1882, amount available	\$1,042 24
Amount appropriated by act passed August 2, 1882	1,500 00
	2,542 24
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	88 00
July 1, 1883, amount available	2,454 24
Amount (estimated) required for completion of existing project	2,460 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	2,460 00

Q 7.

IMPROVEMENT OF TICKFAW RIVER, LOUISIANA.

At the beginning of the year work on this river was in progress under the contract of William Fagan. This was completed in July, 1882, and resulted in clearing out the river for a distance of 18½ miles from the mouth.

In act of Congress of August 2, 1882, an additional appropriation of \$2,000 was made for continuing the improvement. The work was advertised and bids opened October 12, 1882. The following is an abstract of the bids:

Abstract of proposals received in response to advertisement dated September 11, 1882, and opened October 12, 1882, by Amos Stickney, Major, Corps of Engineers, for improving Tickfaw River, Louisiana.

No.	Names of bidders.	Amount per mile for removal of obstructions.
1.	G. A. Meyer	\$380 00
2.	John Maguire*	476 00

* Received after time set for opening proposals. Held at the post-office for non-payment of postage, the postage having been insufficient.

G. A. Meyer being the lowest responsible bidder, it was recommended that the contract be awarded to him. Before the award was made, however, Mr. Meyer, who was engaged in other contract work under the direction of this office, showed an inability to carry on his work according to agreement, and there being considerable difficulty with contract work in other rivers in this vicinity, it was decided, with the approval of the Chief of Engineers, to carry on the work by hired labor in connection with the improvement of the Amite and Tchefuncte rivers, one plant being used for all.

Work on this river will probably be commenced under this arrangement after the completion of the work on the Amite. The original estimate for this improvement included short reaches of the Blood, Natalbany, and Ponchatoula rivers, at their junction with the Tickfaw, and as the appropriations were made on this estimate it will not be changed.

This work originated in an examination authorized by act of Congress, approved March 3, 1879, a report of which, together with plan and estimate of cost, was published in Report of Chief of Engineers for 1880, Appendix M.

The improvement is not considered a permanent one, as the obstructions are liable to reform at any time.

COMMERCIAL STATISTICS.

The work already done on this river has not so far resulted in a marked increase in the amount of commerce, as the improvement only extended about 3 miles above the former head of navigation. The extension of the work under the amount available will carry it to near Centreville, the parish-seat, where there is soon to be erected a saw-mill, also a cotton-gin and grist-mill. A great deal of cotton, sugar, lumber, wood, &c., will be shipped from this point, and the commerce will be sufficient to employ three schooners in addition to the number already in the river. The country bordering this river is rich and fer-

tile, being covered with a magnificent growth of valuable timber that is inaccessible by any other route.

The work is located in the collection district of New Orleans. The nearest light-house is at the mouth of Pass Manchac.

Original estimate	\$10,230 00
Total amount appropriated	4,000 00
Total amount expended	2,004 64

Money statement.

July 1, 1882, amount available	\$1,915 26
Amount appropriated by act passed August 2, 1882	2,000 00
	3,915 26
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	1,919 90
July 1, 1883, amount available	1,995 36
Amount (estimated) required for completion of existing project	6,230 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	6,230 00

Q 8.

IMPROVEMENT OF BAYOU TECHE FROM SAINT MARTINSVILLE TO PORT BARRE, LOUISIANA.

The amount available for this work on July 1, 1882, was \$19,464.65, and the project for expenditures from this amount, as approved by the Chief of Engineers under date of May 12, 1881, was as follows:

PROJECT.

Before submitting a detailed project for this work which will include exact location and general detailed plans for a lock and dam, it is considered necessary to make an exact instrumental survey from Saint Martinsville to Port Barre, and this constitutes this preliminary project. The survey will include transit and level lines, soundings and plottings on a working scale, and the preparation of plans will cover details and estimates for which data now at hand are not sufficient. The examination of 1880 was but a reconnaissance without instrumental work.

It is proposed for the survey to place on the duty the same party as last year provided for the Courtableau, at same rate of wages, except for principal assistant (now at \$200 per month), and to keep total expense within \$2,500.

The survey, as provided for in above project, was for some reason not made by my predecessor in the season of 1881. It was made during the past season, and the report of H. C. Collins, assistant engineer, gives details as far as possible previous to the plotting of the field work.

The original estimate for this work was made in 1880, upon an examination that was only a reconnaissance, and was based upon the construction of locks that were to be built of timber. No dredging was estimated for, and the clearing of the river from Leonville to Port Barre was not provided for, as the information obtained in the examination of 1879 led to the belief that there was no water for passage of boats except in extreme floods. The survey of the past year furnishes information quite different with regard to the upper part of the bayou,

and a detailed estimate for the work will be made as soon as possible. The levels show that, with two locks, having a lift of about 8 feet each, a depth of 5 feet can be carried in extreme low water to within 4 miles of Port Barre, and in ordinary high water there is a navigable depth for small boats the entire distance. Whether it will be worth the cost to make low-water navigation on this reach of 4 miles is somewhat questionable, but the high-water navigation only needs the cutting out of trees to make a fairly good channel. The estimate of cost of improvement in Mr. Collins's report is an approximate one, and includes dredging of bars and removal of logs, &c., below Saint Martinsville, which would be required to carry the 5-foot channel up to Saint Martinsville. I would recommend that an appropriation of \$50,000 be made for the fiscal year ending June 30, 1885, so that the first lock could be built and the bayou dredged and cleared below Saint Martinsville. The commerce of Bayou Teche is rapidly increasing, and the improvement of the navigation would seem to be well worth the expenditure of a reasonable amount of money.

This work originated in an examination authorized by act of Congress approved March 3, 1879, a report of which, together with plan and estimate, was published in Report of Chief of Engineers for 1880, Appendix M.

The improvement is considered as permanent, in the ordinary acceptance of the term, as applied to works of this character.

COMMERCIAL STATISTICS.

The commerce of the bayou includes about all the business transacted in the three parishes that the bayou runs through, consisting of sugar, molasses, rice, corn, and most all other agricultural products adapted to this climate; these are exports. General merchandise, coal, wood, machinery, logs, split lumber, &c., are imports; also a very large amount of sawed lumber.

The actual commerce of the country watered by the Teche is carried on by some eighty country merchants, planters, and direct orders, and amounts to over \$2,000,000 in merchandise and supplies from the North, West, and from New Orleans. In 1860 this region produced a crop of 18,000 hogsheads of sugar and about 30,000 barrels of molasses. It now produces over 15,000 bales of cotton, besides cattle, wool, hides, moss, lumber, &c.

A cotton-mill, and cotton-seed-oil factory are shortly to be constructed by a stock company at Saint Martinsville.

The work is located in the collection district of New Orleans. The nearest light-house is at the entrance to Atchafalaya Bay.

Original estimate	\$56,690 00
Total amount appropriated	26,000 00
Total amount expended	10,348 62

Money statement.

July 1, 1882, amount available	\$19,464 65
July 1, 1883 amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$23,724 60
July 1, 1883, outstanding liabilities	88 67
	<hr/> 3,813 27
July 1, 1883, amount available	15,651 38
Amount (estimated) required for completion of proposed project	130,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885 ..	50,000 00

REPORT OF H. C. COLLINS, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *June 30, 1883.*

SIR: I have the honor to submit the following report on Bayou Teche for the year now ending.

At the beginning of the year, July 1, 1882, the water was very high from the Atchafalaya flood; all the lower lands were yet submerged. On the fall of the river the survey was begun immediately after completion of that for Charenton Canal.

I reached the point of beginning with a party of five men and a cook, and a flat-boat to live on, October 26, 1882. Gauges had been established in the Teche and in Grand Lake the previous month for the canal survey. The readings of the gauges showed that the mean level of the Teche for October was $+1.045$ above the zero assumed; that for November $+0.438$, and for December until the rains came was $+0.345$. There had been a drought in the region supplying the Teche since the July before. A northerly gale occurred. On November 18 the water of the Teche fell to -1.25 feet. Next day, the wind having fallen, the water stood at $+0.2$. Again, on the 16th of December, in a northwest gale, the water fell from $+0.65$ to -1.3 feet in a few hours, and next morning had risen to $+0.125$ foot. These are considered very unusual falls, and the assumed zero is certainly below mean low water of any period of drought. Every clear night, observations on circumpolar stars were made to correct azimuth. Transit points were strong stakes driven into the ground, with the tops rising about 20 inches, and a nail in top of the stake was the transit point.

All distances were measured by stadia-rod readings, checked several times a day by steel tape. From five to seven bench-marks were put in to the mile, and wherever possible they were cut on live-oak trees. A galvanized spike was driven in for elevations, a blaze was made 2 or 3 feet above the bench-marks, and its number cut on it with a timber scribe. They were located on the transit line, as were corners of sugar houses and all permanent buildings where not too distant from the line, in order to afford points for future connection. Topography was sketched in by eye, aided by stadia readings, to all important points.

Cross-sections were sounded as often as necessary to show the channel, bars, and other obstructions, and were located by stadia readings to each side at water edge, where two stakes were shoved down, which held a line with tags every 10 feet. Soundings were taken at every tag, and wherever between tags a log was found its exact place was given. Logs or other obstructions found and not on cross-section line were located by stadia readings. Wherever it was needed to show the whole valley the cross-section lines were prolonged to top of the ridge, or above high-water mark at least, by taking a stadia reading to each place on the line where there was a change of direction of the profile of the cross-section, and reading its elevation on a reading-rod marked on edge of the stadia rod. As I ran both transit and level instruments and both were set up at and near each cross-section line at the same time, little time was used by taking the cross-sections in this way. The survey began at the Teche end of the Charenton Canal, and was connected with it. In working up the stream we placed a gauge at Saint Martinsville and at Breaux Bridge, and employed citizens to read each. The evening of December 20 the rain began, and it continued almost without intermission until January 15. The water rose 17 feet above low water, and the current was so strong that the men could not pull the flat-boat up against it. Soon as it was certain that no work could be done immediately, I went up to the Courtableau work and stopped that, and took three men from there down to the survey, reaching the flat-boat on the evening of January 15; with this addition to the force, we warped the boat up to Port Barre, at the head of the Teche, where it leaves the Courtableau. Here I began the survey again, connecting with the survey made of the Courtableau in 1880, and drifting down the Teche, checking the level line as I went, and connected with the line previously run on the 21st of February. From there down to Charenton, the place of beginning, I ran a check level line. It had been the intention to run this level line down to Morgan City, to connect with the gauge there, but it was not possible to do so at the time. I reached Charenton March 13 with but three men, and each of them had chills daily. From the first the work had been much delayed by sickness of the men.

Swamp fever was prevalent throughout the Atchafalaya, after the fall of the water, and as men became worse after the exposure of the pull from Breaux Bridge up to Courtableau, one after another had to stop; it was not possible to replace them with others. The remainder of this level line can be run at any time when there is an opportunity after beginning of work. Note books were turned over to the draughtsman, but the chart is not yet made, and it will not be possible to write a very complete detailed report until it is done. I will, however, give as full a sketch of the bayou and the results of the survey and plans for its improvement as I can before the final completion of the charts and profiles. Opening the Atchafalaya and its enlargement did not affect the plantations of the Teche so soon as did those of Belle River and the Chêne, but in 1874 it flooded the left bank, destroying cane on all the lower banks. The flood of 1882 rose nearly 5 feet at Charenton above that of 1874, and almost en-

tirely ruined the plantations of the left bank, and below Bayou Salé those of the right bank also. The cultivated land of the left bank extended from its head at the Courtableau to its mouth in the Lower Atchafalaya, with a width of from 1 to 5 miles.

There are a few small tracts of woodland, but nearly all the land has for many years been in constant cultivation. The Teche appears to have had at some former time a width of 450 to 700 feet. The material of the banks is, so far as I can see, identical with that of the Boeuf and of Red River, of which it must then have been the lower portion, but the present width is from 100 to 200 feet for the Lower Teche, and its depth is at low water seldom more than 10 feet. Live-oak trees are found in a continuous belt on each side of the Teche, except where they have been cut for ship timber, or for cultivation of the land. Where thick they protect the banks from washing in heavy rains. The immediate bank of the Teche is higher than it is farther back, and the slope is away from the stream, its drainage being on the left bank to the Grand Lake, and its bayons and on the right to the Vermillion, and farther down to the sea-coast marshes. The natural deposit of the stream at low water is very light, and it is swept out by the current at high-water season, which is about 1½ feet per second.

Many years ago a State law was enacted to prevent drainage into the bayou by deep cauals cut through the natural banks, as it had been found that such drains brought in clay and sand, which the current of the bayou was not sufficient to remove, and there was a bar at every such drainage canal. Since 1865 no care appears to have been taken of the bayou, and many such ditches have been cut, at the mouth of each of which is a bar from 50 to 200 feet long, according to the age of the ditch. At each old saw-mill also there is a bar made by bark, sawdust, worthless logs, and butts of logs, all of which have been put in or allowed to wash in, because there was no one to enforce the law against obstruction of navigable streams. All bars are the result of one or other of these two causes, and can be prevented from again obstructing the stream when once removed. Continuance of this system of drainage will not only spoil the Teche as a navigable stream, but, if carried on long enough, will destroy it as a drainage ditch, as its slope is not steep enough to make a current which will carry out the material washed in from the drainage ditches.

The right or southwest bank of the Teche is considerably higher than the left bank. The same thing also is seen in the Courtableau and Grand River. All these streams run diagonally from northwest to southeast across the general slope of the Atchafalaya Basin, which is from north to south. Freight is shipped directly from each plantation, each having its own landing. The first village above Charenton is Jeanerette, where there are saw-mills. Between here and the next there are two very bad bars caused from drainage canals cut to drain the Grand Marée into the Teche, where its natural and best drainage would be to southward to the Gulf. There are some sunken logs, and some old trees which have been cut or have blown into the bayou, nearly all of which are located on note-books. New Iberia is the next village. It has a good draw-bridge, wide enough not to be an obstruction, and several saw-mills where there are bars caused by their refuse. For several miles the bayou is much obstructed by saw-logs, which are towed in from Grand Lake and stored here. They are so carelessly made fast that a large number of the cribs and very many loose logs are constantly in the channel.

At the time of the survey it was not possible to pass with even a skiff without moving these logs out of the way, and it took steamers more than double the time to make the trips between New Iberia and Saint Martinsville that would have been necessary with the logs properly made fast. Besides the hinderance there is a heavy expense in breakages. There are towed in very many hollow logs, and where they are not of any value, as is usually the case, they are turned adrift, and sink to make bad obstructions.

Above New Iberia is Fausse Point bend which is said to be 18 miles around and is hardly 2 miles across the neck. After running the line around by the bayou to its upper end I ran a check-line across the neck. On Fausse Point bend there are two large sugar refineries and several sugar mills and several cotton gins, but much of the land is divided into long narrow places, with front of a few rods on the Teche and a depth of from 1 to 3 miles. All houses are at the bayou front of the place. On the high land of the west side just above the upper end of the bend is Spanish Lake. Its surface at low water of the survey was 16 feet above the Teche, and it is but a mile distant. There are two ditches which lead into the Teche; one of them was cut to make a water power which for some years was used to grind sugar cane, but it has long been replaced by steam power. Bayou Tortue is the present outlet at high water of the lake, but it only takes water at a height about 2 feet above the stage of last November, when I saw it. Inhabitants say that at the first settlement of the country the outlet was through a slough at the southeast end which has since filled up; that it ran into the Teche on Fausse Point bend; that at that time Bayou Tortue was an inlet bayou from the swamps to northward, between the Teche and Vermillion; and that it had another mouth in the Vermillion. As the lower end of Spanish Lake filled

it raised the water in Bayou Tortue and found a discharge through it into the Vermillion. A line of levels was carried up from the Teche at Keystone plantation to the lake to find the rise.

About 30 cubic feet per second was then running from the lake through the two ditches without reducing the level of the lake, and the discharge is probably never any less. The area of the lake is about 6 square miles of open water, 7 to 15 feet deep, and about half as much of floating grass marsh, which rises and falls with the water of the lake, and would be nearly as useful as a reservoir as the open lake, should it be needed to supply water for lockage in the Teche at low water of a long drought. Six or 7 feet depth of this lake could be used with no harm to any one.

At Saint Martinsville is a pile draw-bridge which was made many years ago, and is too narrow for the large steamers to pass. With an improved bayou it could easily be widened. On one of its piles is a gauge, placed in 1865 by Captain Trinidad. Its zero is the low-water mark of the bayou here, and old inhabitants say it has never been lower within their knowledge. The zero of this gauge is 1.075 feet above the zero of the gauge at Charenton, and the lowest water of 1882 stood at +1 on this gauge. At zero of the gauge a steamer could only reach the upper end of Fausse Point bend, but never, except from heavy gales at extreme low water, does the water fall so low as this zero. Navigation from here to Breaux Bridge lasts for about eight months of the year, and only small steamers run, as only these can pass the draw as it now is. Water shoals more and more from rise of the bottom of the bayou, but the bends are as below, very long, and with water enough there would be no hinderance to the largest boat of the Teche going up and several miles above Arnaudville. The overhanging trees and logs were removed in 1880, but some drift logs have come down since, and many trees have been cut in. The work of that year only went up to Leonville, about 6 miles above Arnaudville. Bayou Fuselier comes in from the west at Arnaudville, and at low water brings in the only water entering above Breaux Bridge. By a low dam on the end of this bayou, which leads to the Vermillion, all of its water can be turned into the Teche, and will furnish enough for lockage to carry slack-water navigation up to within 4 miles of Port Barre. About 15 miles of bayou will need removal of trees, logs, snags, &c., and for three to four months there would then be a good navigable connection with the Courtableau.

It will certainly be possible by dredging to carry low-water navigation through to the Courtableau, but the amount of dredging can be estimated better on completion of the chart. Two locks, with 8½ feet mean lift, will carry navigation up to this last 4 miles of the bayou with an extreme low-water depth of 5 feet, but seldom getting below 6 feet. Steamers now running between New Orleans and Saint Martinsville are Key West and J. W. Chambers. They are 230 feet long and 45 feet wide, about, over all; are stern-wheel boats, which are the only kind that can run without injury to navigation, as side-wheel boats wash the banks so much as to be a great injury to the navigation. All large ones formerly running have been taken off. These boats draw 2½ feet light, and load to 5 feet or more according to the stage of water. They made regular trips through the low water of 1882, and have very seldom missed a trip.

Methods of farming have changed very much below Saint Martinsville, where there is navigation all the time. The large places only formerly raised sugar, and small planters raised cotton. Now sugar-cane is grown on small places and towed in flat-boats to sugar mills where it sells at \$4 to \$5 per ton, and is said to pay far better than cotton. Many large planters raise cane and grind it and boil to syrup and then run it into tanks on flat-boats and it is towed to the refineries to make a higher grade of sugar than could be made on the place. With locks and slack-water navigation this sugar farming would extend to the head of the Teche. It can only be carried on as far up as there is water for boats at lowest stages, that is, in grinding season, October, November, and December. The plans for locks is to build first the lower lock as far up as sufficient depth can be carried at extreme low water. Some bars will require dredging below this. The location will be on Fausse Point bend and not very much below the ditches from Spanish Lake. The lock is to be 300 feet in the clear with a width of 50 feet and fully 5 feet water above the bottom at extreme low water, with a lift of 8 feet. The plan for lock which was made at the first report on the Teche in 1879 was for one of timber entirely. At that time the best red cypress plank could be had for \$12 per M, board measure, and square timber at 10 cents per cubic foot; but now the quality which it would be necessary to use would be worth from 50 to 75 per cent. more. At that time brick or concrete would have cost very much more than it now will, and the cost of annual repairs would be far more for timber than for brick lock; and the speedy renewal which would be required in case of the timber lock would now make it far better to build of brick above low-water line at least. Whatever lock is used, the gates at high water must be opened for free flow of water, and boats could pass with no detention. The deposit formed at low water would, as it now is, be swept out at high water. Brick can be made from the material of the bank. Sand is found in abundance in Atchafalaya, and shell for what concrete is needed are found in very large mounds along Grand Lake. The supply is very much larger than any possible need.

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Estimated cost of improvement would be for two locks, dam, &c., at \$45,000.	\$90, 000
For derrick boat to remove logs, &c., and party one year.....	10, 000
For dredging about 20,000 cubic yards, at 25 cents.....	5, 000
For clearing upper part of bayou for 14 miles	3, 500
Add for contingencies, unforeseen expenses, &c., 25 per cent.....	27, 125
Total.....	135, 625

The commerce of Bayou Teche is now very large. Three large steamers and about twenty small ones are constantly at work. Large quantities of lumber and of sugar and molasses are taken in schooners to sea from the bayou. The local business of the bayou has far more than doubled within a few years as far up as there is water in the sugar-grinding season. A very large amount of coal is towed up the bayou as far as there is now navigation, and with the proposed improvement the increase in cultivation of sugar would greatly increase the demand for coal and for all other transportation.

The amount of sugar-land available by this increase of navigation would be rather more than double what it now is.

Yours, respectfully,

H. C. COLLINS,
Assistant Engineer.

Maj. AMOS STICKNEY,
United States Engineers.

Q 9.

CONNECTING BAYOU TECHE WITH GRAND LAKE AT CHARENTON, LOUISIANA.

The amount appropriated March 3, 1881, for commencing this work is \$25,000.

A project for the expenditure of this money was submitted to the Department by my predecessor, the late Maj. C. W. Howell, under date of April 30, 1881, and was approved May 20, 1881. As preliminary steps with reference to the acquisition of land, cession of jurisdiction, &c., were necessary, the laying out and beginning of work were delayed. These preliminaries were all settled, with exception of registration of deed, by July, 1882, but owing to high water the survey for locating the canal could not be made until September, 1882. In the meantime the deed had been sent to Mr. J. H. Acklen, attorney for the former owners of the land for registration. It was not returned to me until May 9, 1883. It was forwarded to the Department, and in Department letter of May 28, 1883, it was stated that "the deed having been properly recorded, the transfer of the land to the United States, and the cession of jurisdiction from the State of Louisiana being also complete, there appears to be no reason why the work for improving Bayou Teche by connecting same with Grand Lake at Charenton, La., may not be undertaken, and your views in regard to the matter are desired."

On June 29 I submitted the following project :

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 29, 1883.

GENERAL: I have the honor to submit the following project for commencing the work on the Charenton Canal, to connect Bayou Teche with Grand Lake. The amount available for the work is \$22,929.30. The land conveyed to the United States for this canal consists of a strip 500 feet wide, extending across the neck of land between the Teche and the lake, a distance of about 1 mile. The difference in level of water surface between that of the Teche and of the lake varies within limits of 0 to about 3.4 feet. The extreme difference is usually caused by strong winds and does not last but a few hours. Sometimes one and sometimes the other is the higher. The exact excess of height of one above the other has not been determined, but gauges have been set to obtain this information. I think it would be very desirable to construct the canal without a lock, if it should be feasible, which can be determined at a later day.

If it is necessary to construct a lock, I would propose giving the canal a bottom

width of 50 feet. If a lock can be dispensed with, I would propose a bottom width of about 100 feet. I feel quite confident that with a width of 100 feet the water in the lake and Teche would have sufficiently intimate connection to so nearly equalize the levels as not to produce any harmful current, and the cost of the 100-foot cut, without lock, would be less than that of 50 feet with a lock, beside being greatly more favorable for navigation and cost of maintenance. There is very little sediment in the water of the Teche, and therefore giving it another outlet by means of the open canal to the lake, would not cause any great deposit. I would propose to commence the work so it should be a part of either plan, as may be decided later; that is, to excavate the canal along the center line of the 500-foot strip and out to 5 feet depth in the lake, with a bottom width of 50 feet and side slopes of 3 horizontal to 1 vertical; placing the material so as to form banks above high-water level and at a sufficient distance from the cut to leave a berme of at least 25 feet in case the canal should be widened to 100 feet. In the lake a line of piles at intervals of about 6 feet, supporting a continuous line of sheet-piling and braced against a second line, will be necessary to retain the material dredged from the channel at entrance of canal and prevent the cut from filling up. I would propose to begin the work with wheelbarrows or scrapers, excavating enough of the canal by hand to build levees on each side about 3 feet high. The remainder of the canal I propose to excavate by dredge-boat, transporting the dredged material to the line of embankment by means of an endless carrier on a barge worked by steam.

The surface of the ground is an old field, but there is a strong probability that the remains of an old cypress swamp will be found under the surface. In view of this, and the fact that the site is subject to overflow, it would be a very difficult matter to specify the work so that contractors could make reasonable proposals and the United States be exempt from charges for extra and unforeseen work, damages by flood, &c. I therefore recommend that it be done by hired labor and purchase of material in open market. If this meets the approval of the Department, I would request authority to construct a dredge and barge with steam carrier. The cost of this plant would probably not exceed \$15,000, and it would certainly pay for itself in the work. For a bottom width of 50 feet, the excavation would measure about 249,826 cubic yards. For a bottom width of 100 feet, it would be 374,623 cubic yards. The hand-work could be commenced immediately, and when the dredge and carrier are constructed the work could go on without regard to stage of water almost up to high flood.

I transmit herewith a tracing showing the site, with lines of proposed canal and embankment.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

If this project were approved, work could commence at an early day.

The estimates for the cost of this work are made up in two ways: one to show the probable cost of contract work, and the other to show what the work could probably be done for with machinery specially constructed for it. I am quite confident that, owing to the circumstances of the case, the final cost of the work, if done by contract, would be an indefinite sum, which would be made up, to a considerable extent, of extra items, damages and delays by floods, to which the site is subject, the amount of which could not be foretold.

The estimates are as follows:

ESTIMATE No. 1.—*Work done by contract.*

	For canal 50 feet wide with lock.	For canal 100 feet wide without lock.
Canal excavation with material placed in levees.....	\$75,000	\$112,500
Lock 300 feet long, 50 feet wide, double gates.....	45,000	
Fill in lake 1,000 feet long, at \$6.....	6,000	6,000
	126,000	118,500
Contingencies, engineering, office expenses, &c., 10 per cent.....	12,600	11,850
Total.....	138,600	130,350

* 250,000 cubic yards, at 30 cents.

† 375,000 cubic yards, at 30 cents.

ESTIMATE No. 2.—*Work done by hired labor and machinery constructed for it.*

	For canal 50 feet wide with lock.	For canal 100 feet wide without lock.
Cost of one steam dredge	\$12, 000	\$12, 000
Cost of one flat-boat with earth carrier worked by steam	2, 500	2, 500
Excavation of portion of work by hand or scrapers, material placed in levees	*12, 000	†15, 000
Excavation by dredge and carrier material placed in levees	‡1, 000	\$32, 500
Pier in lake 1, 000 feet, at \$6	6, 000	6, 000
Lock 300 feet by 50 feet, double gates	45, 000	.....
	98, 500	68, 000
Contingencies, engineering, office expenses, &c., at 25 per cent.	24, 625	17, 000
Total	123, 125	85, 000

* 40, 000 yards, at 30 cents.
† 50, 000 yards, at 30 cents.

‡ 210, 000 yards, at 10 cents.
§ 325, 000 yards, at 10 cents.

The difference in these two estimates is very considerable; especially for the 100-foot canal. The estimate of the cost for contract work of excavation is based on the contract prices for levee work in this district for levees of similar height, with a small allowance added for draining, which would be necessary, as the bottom of the canal is 5 feet below low water of lake.

The estimate of cost under the system of hired labor with machinery constructed for the work, is based upon the actual work of the dredge now working in Bayou Black. Upon this plan the plant would be on hand after completion of work.

I recommend the appropriation of \$50,000 for the fiscal year ending June 30, 1885.

The following is the report of Assistant Engineer H. C. Collins, in immediate charge of the work:

NEW ORLEANS, June 29, 1883..

SIR: I have the honor to submit the following report on the connection of Bayou Teche with Grand Lake by a canal at Charenton, La.:

At the beginning of the year, July 1, 1882, a large portion of the tract between Bayou Teche and Grand Lake was covered by water from the great Atchafalaya flood of that year. At the height of the flood it had all been covered.

The conveyance of the land from the former owners to the United States was made in December, 1881, but owing to the high water no survey of the tract could be made until the fall of the water in September, 1882. Field work of the year was begun on September 19, 1882. The tract conveyed to the United States for the canal was first laid off.

It is 500 feet in width from the upper end of the plantation and slightly more than a mile long, containing 60.72 acres. Brick corner posts were built at each corner, and on each long line two similar posts were put in at about equal distances apart on the line, plainly marking the boundaries of the tract. A line of wooden posts was driven along the center line of the tract, from the Teche to Grand Lake, at intervals of 50 feet on the steep slope of the Teche and of 100 feet across the nearly level land from the top of this slope to the lake. Gauges were established in the Teche and in Grand Lake. Bench marks were made on several places where they will be secure.

The assumed low water taken for zero of level line is 0.35 below the mean low water of the Teche during the drought that we had in November and the fore part of December, 1882, and more than a foot below that of October. Level line was run over the tract, taking cross-sections at every post, and elevations of each 50 feet from post to edge of the tract, 250 feet on each side, all checked to avoid chance of errors.

Soundings were taken covering about half a mile front of the lake and extending out more than a mile into the lake. On completion of the field work October 1, 1882, a man was employed to continue reading both gauges. Chart and profile of the line was made at once. The question to be considered in excavation of the canal is the width to which it shall be made. From December 20 to March 1 the Teche was higher than the lake, the greatest difference being on the 23d of January, when it reached 3.4 feet.

The 3d of March the lake began to be highest and continued so until the present time, the greatest difference being on the 27th of April, when it was 2.2, but for most of this time ranging from 1 foot to 1.5 foot. The extreme height of the lake in the flood of 1882 was 14.684, while the extreme height of the high water of this year was 7.1 feet in the lake and 5.5 feet in the Teche.

The extreme differences given lasted in each case but a few hours and were effects of the wind in raising one or lowering the other from the mean of the few days before and after. Were there an open cut through, the water in the Teche would remain at very nearly the same height as that of the lake, if the connecting channel were large enough. With a cut with bottom width of only 50 feet the difference of levels would probably be so great as to make an injurious current and destroy banks and fill the canal, and a lock would have to be made to prevent this; but an open cut 100 feet bottom width would pass sufficient water with very slight variation of levels to prevent there ever being enough current to wash or injure the canal. The difference in cost of the excavation in making the canal 100 feet bottom width or 50 feet will be very much less than the cost of building the lock which would certainly be needed with the narrow cut. An open canal would need little expense for care, while a lock would be a great and constant expense. Slopes to prevent sliding in of material will need to be about 1 vertical to 3 horizontal; the proposed depth is 5 feet, same as the lake. The berme should be at least 25 feet and the material taken out will be used for a levee on both sides, which will reach to above the high-water mark. There will also be necessary a pier or breakwater on the east side of the cut in the lake for a distance of 1,000 feet out from shore, to save the cut from being filled by sand and shells in easterly gales. No pier is needed on the west. The angles will have to be rounded off at the Teche entrance to make it practicable for a boat to enter or leave the canal. This and the lake pier will be just the same with the open or locked canal.

Estimate for the lock must certainly be included in the narrow canal, and this lock if made of brick or concrete above low-water mark so as to be permanent, could not be made at much if any less cost than \$45,000. A timber one could be made for less money, but the frequent repairs and speedy renewal would make it more economical to build the better lock at first. The expense of lock repairs and constant attendance would also add greatly to the economy of the open cut. No injury need be feared from teredo, as piles driven in the lake before the war are yet sound.

The cost of the excavation will, I think, depend much on how it is done, but I will first make the estimate on basis of cost for levees in Louisiana at contract prices, much of this material requiring long haul.

Estimate for canal 50 feet bottom width, 5 feet below zero of level line. Slopes 1 vertical to 3 horizontal; material placed in levees:

249,826 cubic yards, @ 30 cents	\$74,947 80
Lock 300 by 50 feet wide—double gate	45,000 00
Pier in lake 1,000 feet long, @ \$6	6,000 00
Add 10 per cent. for engineering, office expenses, &c.	12,594 70
	<hr/>
	138,542 50

For canal 100 feet bottom width, same slope, levees, &c.:

374,623 cubic yards, @ 30 cents	\$112,386 90
Pier as above	6,000 00
Add 10 per cent. for engineering, &c., as above	11,838 60
	<hr/>
	130,225 50

At the estimated price per yard it is by no means certain that a contract could be let without some stipulation for extra pay in case of stumps, logs, or other obstructions to the work being found, as is quite probable that there will be.

ESTIMATE TO DO THE WORK BY HIRED LABOR.

To build a dredge-boat for the work which will be needed for removal of bars in the Teche and other bayous of this department will cost	\$12,000
Scow with carrier, engine-pump, &c.	2,500
Lever to raise water 2 feet above land	4,000
Pier in lake 1,000 feet long, @ \$6	6,000
Pay-roll, fuel, supplies, &c., for time necessary to do the work, at 500 yards per day average	38,600
Add for contingencies, office expenses, engineering, &c., 25 per cent	15,625
	<hr/>
	78,125

The estimate for the 50-foot*locked canal would be changed from this by about adding cost of lock and subtracting \$13,000 saved on dredging, or an increase of

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\$32,000, and a further increase of whatever sum was necessary to keep up lock and pay for attendance.

Yours, respectfully,

H. C. COLLINS,
Assistant Engineer.

Maj. AMOS STICKNEY,
United States Engineer.

This work originated in an examination authorized by joint resolution approved June 28, 1879, a report of which, together with plan and estimate, was published in Report of Chief of Engineers for 1880, Appendix M.

The work will constitute a permanent improvement in the ordinary acceptance of the word "permanent."

The commerce of the proposed canal will be that of the Bayou Teche, and is given in the report on that work.

The work is situated in the collection district of New Orleans. The nearest light-house is at the mouth of the Atchafalaya River.

Original estimate	\$75,000 00
Total amount appropriated	25,000 00
Total amount expended	2,095 70

Money statement.

July 1, 1882, amount available	\$24,226 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$1,296 70
July 1, 1883, outstanding liabilities	25 00
	<hr/> 1,321 70
July 1, 1883, amount available	<hr/> 22,904 30
Amount (estimated) required for completion of existing project	50,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	50,000 00

Q 10.

IMPROVEMENT OF BAYOU BLACK, LOUISIANA.

The dredge-boat constructed for operating in Bayous Black and Terrebonne was completed about the beginning of the fiscal year.

The work having been previously commenced in Bayou Terrebonne, the dredge-boat was sent first to that bayou, where it remained at work till April 14, 1883, when the funds for that bayou were about exhausted. On April 29, 1883, the steamer Sammy, which was sent around to the Terrebonne from Morgan City, took the dredge in tow and passing through Terrebonne Bay, and by way of the Gulf conveyed it into Bayou Black as far as Tigerville, where it arrived on May 7, 1883. Work was immediately commenced at this point, and by the 30th of June the dredge had proceeded a distance of 5,665 feet, making a channel 50 feet wide and 6 feet deep, and excavating about 21,000 cubic yards of earth, and removing 161 logs and stumps and one steamboat and one flat-boat wreck.

Dredging in this bayou has been found more difficult than in the Terrebonne, on account of the greater number of logs. The amount available for this bayou is sufficient to keep the dredge-boat constantly at work during the entire year, which is a fortunate circumstance, as the appropriation for Bayou Terrebonne is about exhausted.

The original estimate for this work was \$47,520, of which \$27,520 yet remains to be appropriated. I recommend that \$15,000 of this amount be appropriated for the year ending June 30, 1885.

The examination of this bayou was provided for in the river and harbor act approved June 14, 1880, a report of which, together with the plan and estimate of cost of improvement, was published in Report of Chief of Engineers for 1881, Appendix M 11.

COMMERCIAL STATISTICS.

The crop of Bayou Black this year will be about—

Sugar	hogsheads..	7, 000
Molasses	barrels..	14, 000
Corn	do..	50, 000
Rice	do.	5, 000

The freight on the above with the return freight will be over \$100,000. With water communications to New Orleans it will not be half as much. The freights of one plantation amount to about \$9,000 per annum, and as there are quite a number of sugar plantations on the bayou, the commerce to be benefited is quite valuable.

The work is located in the collection district of New Orleans. The nearest light-house is at the entrance of Atchafalaya Bay.

Original estimate	\$47, 520 00
Total amount appropriated	20, 000 00
Total amount expended	8, 611 49

Money statement.

July 1, 1882, amount available	\$5, 040 84
Amount appropriated by act passed August 2, 1882	10, 000 00
	<hr/> 15, 040 84
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$2, 858 12
July 1, 1883, outstanding liabilities	794 21
	<hr/> 3, 652 33
July 1, 1883, amount available	<hr/> 11, 388 51
Amount (estimated) required for completion of existing project	27, 520 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	15, 000 00

Q II.

IMPROVEMENT OF BAYOU COURTABLEAU, LOUISIANA.

No appropriation was made for this improvement in the act of Congress of August 2, 1882, but there remained on hand from previous appropriations and available on July 1, 1882, \$6,085.15.

The flood of the spring of 1882, deeply inundated the region of country through which Bayou Courtableau runs, and work could not be resumed on the improvement until the middle of October. It was then carried on with considerable hinderance from swamp fever until January 6, 1883, when high water again suspended operations. The report of Assistant Engineer H. C. Collins, under whom the work was conducted, gives the details. The results of the work so far are very favorable, and it is expected that by the next low-water season the bar at the mouth of the bayou will have ceased to be an obstruction.

Mr. Collins believes that the amount originally estimated for closing the run-out bayous, removing snags and overhanging trees, will be sufficient for that work; but, for the reasons mentioned in his report,

the estimate for a lock to carry the low-water navigation up to Washington, as made in 1879, viz, \$16,500, is entirely too small. That estimate was based upon the price of timber and labor at that time and was for a lock entirely of timber. Owing to the rapid decay of timber in this climate I do not think it should be used where it can be avoided above water for works which are intended for any permanency. Mr. Collins's revised estimate for lock with brick walls on pile and timber foundation is \$45,000. The construction of the lock cannot be commenced, however, until the closing of the run-out bayous and cutting out of the Little Devil Bar develops a new low-water surface. I therefore recommend for the fiscal year ending June 30, 1885, only the appropriation of the amount necessary for the latter work, viz, \$8,000.

This work originated in an examination authorized by act of Congress approved March 3, 1879, a report of which, together with plan and estimate for improvement, was published in Report of Chief of Engineers for 1880, Appendix M.

The work is considered to be permanent in the ordinary acceptation of the term as applied to works of this kind.

COMMERCIAL STATISTICS.

There are few streams of its size that can boast of as large an amount of business as this bayou. It is not the business done immediately on this bayou, but the ones that form it, which are Bayous Cocodrie and Beauf. These streams intersect a vast region of country that is thickly settled, and their only natural communication with the markets is via Bayou Courtableau.

The work is located in the collection district of New Orleans; the nearest light-house is at the entrance to Atchafalaya Bay.

Original estimate	\$40,000 00
Additional estimate for increased cost of lock	38,500 00
Total amount appropriated	15,000 00
Total amount expended	12,106 44

Money statement.

July 1, 1882, amount available	\$6,085 15
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	3,191 59
July 1, 1883, amount available	2,893 56
Amount (estimated) required for completion of existing project	63,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1885 ..	8,000 00

REPORT OF H. C. COLLINS, ASSISTANT ENGINEER.

NEW ORLEANS, July 1, 1883.

SIR: I have the honor to submit the following report on the work of improving Bayou Courtableau, Louisiana, for the year ending June 30, 1883:

At the beginning of the year, in July, 1882, the water of the Atchafalaya Basin, of which the Courtableau is a part, was very high and had only fallen low enough so work could be resumed the middle of October. Gauge-records had been continued throughout the whole period of the flood, and up to arrival of party and beginning of the work, October 17. The working force consisted of Mr. R. Niemeyer, overseer, with twenty men. A careful examination of the condition of the work done the previous year was made at once, and the bayous, which had been closed as much as practicable with trees and drift, had not cut out at all, and the dam which had been made on Big Fordoche was in good condition. The Little Devil Bar was nearly dry, and nearly the entire discharge of the Courtableau was passing down the Little Fordoche Bayou, the

other bayous having been filled with sand, owing to the obstructions of the current, so much as to entirely close them to just above the level to which the water in the Courtableau had then fallen.

Examination of Little Fordoche showed that the current had washed out the sand which had been deposited in it, as well as the others, and carried it down into deep pools, and a place was found just above the upper block of drift, where the clay bottom was clear of logs and mud for a length of 150 feet and for the whole width of the bayou, with good clay banks and some very large trees standing on and near the banks, which would afford good support to the dam to be made.

The bottom width was 65 feet and depth of water 7½ feet. The surface of water was 95 feet wide and banks 8 feet high and 110 feet apart at top. It was about 450 feet below the head of the bayou in the Courtableau, and was the highest clay bank on the stream, and the land on both sides well protected from washing by a dense growth of trees and bushes.

The dam was begun by rows of piles driven 4 to 6 feet into the clay bottom, and rising 2 to 6 feet above water. Eight rows of these small piles were driven at intervals of 7 to 12 feet, and the piles were 2 to 2½ feet apart in the row. Then the whole was filled with fine brush over the whole bottom, which, when packed by clay, which was used to sink it, was about 1 foot thick. Then a brush dam was raised to the surface of the water on the three lower spaces, clay being constantly put on top to sink the brush as it was placed. The clay was wheeled in from the bank, leaving sufficient width to prevent danger from washing between the bayou and pit. This first narrow dam reached the surface and cut off nearly all the discharge of water down Little Fordoche the 10th day of the work, but the water was not entirely stopped until a clay front had been put in and raised to the surface, which took nearly as long as it did to put in the first.

The first closure threw enough water over Little Devil Bar to cut it down 3 feet on the crest in two days, so that the little steamer could cross to transfer her freight directly to the large steamer. When this was accomplished the real work of building the dam had only begun. The down-stream end of the dam was raised slowly by brush layers, each of which extended up until they reached the bed mattress, the tops of the piles being sharpened as the brush layers had nearly reached them, so as to allow for settling of the whole, and sufficient clay was put on so that all spaces were filled. Brush was mostly willow, cut along the bank of the Courtableau, and brought in on small flat-boats. As the last few piles of a row were nearly covered, another row of longer ones were driven between them. The first had been driven by heavy wooden mauls, but a small hand-driver was rigged, and larger, longer piles driven through the dam, reaching generally about as far into the bed of the bayou as the first had. These last piles were 6 to 10 inches diameter at butts, which were up. All tops were sharpened as the first had been when the dam had been built up nearly to them. This dam was carried up 4 feet above the surface of the land, and at the top was but 30 feet wide. The first brush mattress of the bottom was 85 feet long, and an apron was built in of whole trees on the lower side as the dam was raised, which extended the length 35 feet farther down-stream. Wings built like the dam reached out 60 feet at each bank. Heavy cypress timbers were laid along the top and a row of piles were driven on each side of them and drift-bolted to them. Other large cypress timbers were laid as stays and fastened with 1-inch-square rag-bolts to large trees growing near, and to the cypress cross-timbers.

The reason for raising this dam above the surface of the land was that our experience in the flood of the previous year had shown that as the water rose there was a strong current down the south side outlet bayous, and that when it got over the whole land to a depth of about 3 feet the swamps and deep channels filled with water and there was a uniform current over the whole country, but that it was so checked by trees and brush as not to be strong enough to wash the surface. Very few instances were noticed where it exceeded 1 foot per second for 50 feet, and the average velocity was barely half that, while for the little time of the rise, from where it covered the surface until it had got up 2 or 3 feet, there was a rapid current in every open place, such as the crest of the dam would be were it only raised to level with the surface. The dam was finished January 6, 1883, and the rise of the river had then raised the water nearly a foot above the general surface of the land. Work was then closed, and boats and tools stored in warehouse at Port Barre. Work was very much hindered by prevalence of swamp fever everywhere in the Atchafalaya Basin. Sick men left and other men were hired to take their places, until it was not possible to hire men.

The railroad company and levee contractors were paying men more than double the wages given on this work, and the dam was finished by men who were down with swamp fever and able to do but about half work, and but four even of these sick men at last.

The entire amount expended during the year, including gauge-reading before the work began, pay-rolls, supplies, office expenses, and engineering amount to \$3,191.50.

1124 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

The present condition of the work is this: the land is covered by about 3 feet of water, but it has been fully 2 feet lower since the extreme height of the rise in April, when it was about 9 feet deep over the land, or 5 feet above the top of Little Fordoche Dam.

Captain Trousdale, of the steamer Fanchon, informs me that the dam has stood the high water with no damage, and that there has been a fill of sand below the dam, reaching above the top of the water as it was last month. This must have been caused by an eddy in lee of the dam while the water was rising or falling and just below the top. The dam on Big Fordoche, made the year before, appears to be all right, but is some feet below water yet. This was not raised last winter, as we had intended, on account of the force having been so much reduced by sickness that the Little Fordoche Dam was all it was possible to do. It is expected that the first rise which comes in the Courtableau, at a time of low water in the Atchafalaya, will sweep out Little Devil Bar entirely, and if the four large bayous are closed that it will not be possible for Little Devil Bar to be formed again. In 1882 the period of low water in the Atchafalaya was very short, and for the whole time when it was low there was a drought in the region supplying the Courtableau. The overhanging trees and snags on the Courtableau, between the Atchafalaya and the head of the Teche at Port Barre, have been removed by the hands at work on the dams.

There yet remains to be done of the work originally proposed, the removal of snags and overhanging trees between Port Barre and Washington, La., and closure of bayous Mamzelle and English, and raising the dam on Big Fordoche about $7\frac{1}{2}$ feet, and a lock in Bayou Courtableau below Port Barre with lift sufficient to carry low-water navigation up to Washington.

The original estimate for the work already begun was—

For removal of snags and overhanging trees	\$900
For closure of run-out bayous	20,000
For contingencies, office expenses, &c., 10 per cent	2,090
	<hr/>
	22,990
And there has been appropriated	15,000
	<hr/>
	7,990

Probably this amount will, with the money on hand, be sufficient to complete this part of the work, but the estimate for the lock which was made in 1879, of	15,000
Contingencies, 10 per cent	1,500
	<hr/>
Total	16,500

was made for a timber lock, and was based on price of cypress timber at that time, which is now worth 50 per cent. more than it then was, and on labor at about the same rate we have since paid; but at that time nothing was known of the facts about swamp fever, which we have found by experience will very nearly double the cost of labor.

A revision of plan of and estimate for lock should be made, and a lock put in that will not need the constant repairs and speedy renewal that one of timber entirely certainly would. A lock made with brick walls and dam based on pile and timber foundation entirely below low water would cost so little in excess of the cost of a timber one under the present conditions that it would certainly be economy to change the plan. The cost of such a lock 300 feet long and 50 feet wide will probably not exceed \$45,000 to build by hired labor, and work already done on this bayou shows that it is much better to do it by hired labor than by contract.

The commercial importance of this work, even for the present steamboat route between New Orleans and Washington, is very great, and should the work of improvement be extended up Bayou Boeuf, as was expected at the time this work was begun, it would be far more than doubled. Removal of Little Devil Bar and slack-water navigation to Washington would very greatly increase the present trade. During the business portion of the year, for about seven months, two steamers of from 2,500 to 3,000 bales capacity make regular weekly round trips, and for the remainder of the year one boat makes the round trip each week, carrying paying and usually full loads. They carry up supplies and bring out sugar, cotton, and country produce.

Besides these large steamers a large amount of staves, split fencing, and shingles are taken up the bayou on flat-boats, and small steamers tow up sufficient logs to supply two large saw-mills at Washington.

Yours, respectfully,

H. C. COLLINS,
Assistant Engineer.

Maj. AMOS STICKNEY,
United States Engineers.

Q 12.

IMPROVEMENT OF BAYOU TERREBONNE, LOUISIANA.

The dredge-boat constructed for Bayous Terrebonne and Black was finished about the beginning of the fiscal year. On August 24, 1882, it was started under tow for Bayou Terrebonne, by way of the Mississippi River and Bayou La Fourche. It reached the point where it was to begin work, about 15 miles from Houma, on September 1, 1882. Dredging was commenced September 2, 1882, and steadily prosecuted till October 12, 1882, when the resignation of the overseer in charge caused suspension of work. Owing to difficulty in finding a competent overseer work was delayed until November 6, 1882. Dredging was resumed on that date and continued until April 14, 1883, when, the funds being about exhausted, operations were suspended, and, on April 29, 1883, the dredge started for Bayou Black.

The result of the work was the cutting of a channel 40 feet wide 6 feet deep for a distance of 21,655 feet, and excavating about 92,310 cubic yards of earth, and removing 606 logs and stumps. This brings the improved channel to within 10½ miles of Houma.

Near the point where the work was stopped a turning place was dredged so that vessels could be turned about. There being no available funds remaining, no work can be done during this year. It is recommended that the unappropriated balance of estimate of last year for completion of improvement, viz, \$13,000, be appropriated for fiscal year ending June 30, 1885.

This work originated in an examination authorized by act of Congress approved March 3, 1879, a report of which, together with plan for improvement and estimate of cost of same, was published in Report of Chief of Engineers for 1880, Appendix M.

Owing to the numerous drainage ditches having outlet in the bayou the work cannot be regarded as permanent unless some change is made in the method of draining.

COMMERCIAL STATISTICS.

The Morgan Railroad has a branch 14 miles long between Terrebonne Station and Houma, and during the sugar season freight is brought up the bayou to the railroad in flat-boats, cordelled to a point 6 miles below Houma, where a small steamboat takes them in tow for the remainder of the distance. The commerce to be benefited by this improvement includes the whole amount coming to the town of Houma by water up the bayou, which in 1878-'79 consisted of 14,175 hogsheads of sugar, 20,840 barrels of molasses, much rice and other produce.

The work is located in the collection district of New Orleans. The nearest light-house is near the eastern end of Timbalier Island.

Original estimate	\$18,800 00
Additional estimates of 1881 and 1882, for completion to Houma	20,000 00
Total amount appropriated	25,800 00
Total amount expended	25,706 58

Money statement.

July 1, 1882, amount available.....	\$1,577 19
Amount appropriated by act passed August 2, 1882.....	7,000 00
	<hr/> 8,577 19
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$8,463 77
July 1, 1883, outstanding liabilities.....	20 00
	<hr/> 8,483 77
July 1, 1883, amount available.....	93 42
	<hr/> 13,000 00
Amount (estimated) required for completion of existing project.....	13,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	13,000 00

Q 13.

IMPROVEMENT OF BAYOU LA FOURCHE, LOUISIANA.

The work of removing obstructions from this bayou had reached a point 17 miles below Lockport at the time of suspension of operations, December 31, 1881. Work could not be resumed, owing to high water, until September 21, 1882. From that time until January 31, 1883, the work in charge of an overseer was carried on steadily. The funds being then nearly exhausted, and the water getting too high, the working boat was cordelled up to Lockport and laid up. About 13 miles of the bayou was cleared beyond the point worked to last year, and some obstructions were taken from reaches that were worked over last year, which carries the work to 30 miles below Lockport. Four hundred and eighty-seven obstructions, consisting of stumps, logs, and trees, besides four flat-boat wrecks, were removed from the bayou, and about 2½ miles of overhanging willow trees, which were obstructing navigation, were cut and cleared from the banks.

To continue this work to the mouth of the bayou an additional appropriation of \$15,000 will be required.

In the river and harbor act of August 2, 1882, a provision was made for a survey of this bayou. A preliminary report on this was forwarded on August 30, 1882, and in Department letter of April 24, 1883, it was directed that the survey should be made. After the survey a more comprehensive plan of improvement can be projected. This work originated from surveys authorized by act of Congress approved March 3, 1873, for reports of which see Reports of Chief of Engineers for 1874 (Appendix R 13) and 1875 (Appendix S 5). The work, so far as the removal of obstructions is concerned, may be considered as susceptible of permanent completion.

COMMERCIAL STATISTICS.

The overseer of this work reports that commerce has been much benefited by the work already done; the number of vessels have greatly increased, and trade increases steadily as the obstructions are removed.

The work is located in the collection district of New Orleans. The nearest light-houses are at the mouth of the Mississippi River and at the entrance to Atchafalaya Bay.

Original estimate	\$100,000 00
Total amount appropriated.....	25,000 00
Total amount expended	24,324 99

Money statement.

July 1, 1882, amount available.....	\$4,663 92
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$3,926 91
July 1, 1883, outstanding liabilities.....	62 00
	<hr/> 3,988 91
July 1, 1883, amount available.....	<hr/> 675 01
Amount (estimated) required for completion of existing project.....	15,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	5,000 00

Q 14.

IMPROVEMENT OF CALCASIEU RIVER, LOUISIANA.

The amount available for this work on July 1, 1882, was \$2,991.39; the amount appropriated by act of Congress passed August 2, 1882, was \$7,000; making a total of \$9,991.39. Owing to the fact that the original survey of this river did not extend below Lake Charles, while the greater part of the commerce of the river was on this lower reach, it was deemed advisable, before making any project for the work, to have the lower part of the river examined. Mr. W. S. Davis, assistant engineer, was directed to make the examination from Lake Charles to Calcasieu Lake. The following is his report:

REPORT OF MR. W. S. DAVIS, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *April 2, 1883.*

MAJOR: In compliance with instructions from Capt. D. W. Lockwood, Corps of Engineers, dated March 14, 1883, I have the honor to submit the following report of examination of that part of Calcasieu River, Louisiana, between Lakes Charles and Calcasieu:

On 20th of March I reached Lake Charles, seat of Calcasieu Parish, situated on the eastern shore of a lake of same name, and on the Louisiana Western Railroad, 198 miles west of New Orleans, and spent the two following days there getting information as to where the most troublesome obstructions are encountered by schooners plying in the river.

As Calcasieu River is navigated by schooners almost exclusively, I learned from the captains of these that only three bars lie in the way to navigation, viz, the two mud bars in Calcasieu Lake, one at its entrance and the other at its outlet, and the third, a sandbar at the mouth of the river known as "the outer bar." The remaining part of the river is deep and comparatively free from snags.

On 23d I went down the river on the steamer carrying the mail between Lake Charles and Leesburg (at "The Pass"), took soundings, at short intervals, from the bow of the steamer, and sketched the topography as accurately as I could.

The average depth of Lake Charles is 8 feet, except along the western shore in the river channel, where it is more than 12 feet. Below Lake Charles the river meanders through a broad low prairie, occasionally touching strips of higher timbered land on which residences and landings are located. This part of the river is from 18 to 30 feet deep and 400 to 600 feet wide, except in the lakes through which it runs, where the depth is from 8 to 12 feet, and width of lakes several thousand feet. In one of these (known as Prien's Lake or Little Lake) I found 8 feet on a bar 300 feet long opposite Lock's Landing, but the pilot said that we were out of the channel, and that the depth over the bar in the channel is 10 feet. On my return the tide was 2½ or 3 feet high, when I sounded again through Prien's Lake, finding a depth of 13 feet. However, boats find no trouble here at extreme low tide. At the head of Calcasieu Lake there is a cut-off or chute through the right bank, forming an island of about 200 acres in area known as "Shell Island."

The depth of water in this chute is 2½ to 3 feet. The passage for boats is to the east and southeast of Shell Island. On the north of island is a depth of 20 feet, but on the east a mud bar sets in, the elevation of which increases in passing down until we reach the southeast side of island, where the sounding was only 6½ feet. When ex-

amed the wind was from the southeast, causing a tide of 1 foot, but when there is a strong northerly wind the minimum depth on bar is $5\frac{1}{2}$ feet. I had no instruments with which to measure bar nor locate soundings over it, but estimate its length to be 3,500 feet. The accompanying map shows position of bar as nearly as I could determine. The river channel across bar is only a slight depression, the position of which is determined by its having a *soft mud bottom*, while the bed of the lake surrounding is shell or covered with shell.

I do not think a channel dredged across the bar would be permanent, from the fact of the mud being so soft that the waves from the lake would soon wash it back again. A system of lightly constructed jetties, built of brush fascines across the bar, and held in position by stakes driven through them at short intervals, would concentrate the channel and cause the current at ebbing tide to scour a depth sufficient for any schooner that can cross the lake. In addition to these jetties I would suggest the closing of the chute mentioned above by a brush dam of same construction as jetties.

From captains of vessels in the lumber trade and from saw-mill owners and merchants at Lake Charles I have obtained the following information as to the commerce of Calcasieu River:

First. That the upper portion of the Calcasieu Basin lying above Lake Charles is a vast unsettled pine forest, with no commerce, and never navigated except occasionally by a tug-boat sent up to tow down their booms of pine logs, and that the upper part of Calcasieu River is sufficiently deep and offers no obstruction to the navigation for which it is used.

Second. That the commerce of the river below Lake Charles is principally exportation by schooners of lumber sawed at Lake Charles and the importation of merchandise by same conveyance.

Third. That as freights on the railroad are high, the lumber manufacturers can be enabled to compete with other markets only by having cheap transportation, and that if the bars in the lower part of the river were improved they could obtain this cheap transportation by building larger schooners and shipping in larger quantities and to foreign markets.

At Lake Charles there are eleven large lumber mills, with a capacity for sawing daily 398,000 feet. Some of these have planers attached with a daily capacity of 120,000 feet. There are three shingle mills with a capacity for making daily 105,000 cypress shingles, and one rice mill with a capacity for cleaning thirty barrels of rice daily.

The lumbermen have built two steel-rail, narrow-gauge railroads from the river banks in the lumber regions into the interior of the forest, for conveying logs to the river, down which they are rafted. These roads are well constructed; have three locomotives and a full corps of operatives. The estimated amount of pine lumber now in forest tributary to the Calcasieu River is 4,120,000,000 feet. Owing to the rapid growth of small pines, it will require many years to exhaust the lumber of so so extensive a forest.

COMMERCIAL STATISTICS.

Annually shipped by Calcasieu River.

Articles shipped.	Number.	Value
Sawed lumber.....feet.....	38, 000, 000	\$760, 000
Cypress shingles.....	6, 000, 000	24, 000
Rice.....barrels.....	2, 108	14, 390
Return freight.....pkgs.....		528, 000
		1, 328, 390

Mr. T. F. Monroe, deputy collector of United States customs at Leesburg, has kindly furnished me the following statement of vessels playing in the Calcasieu River:

Number of schooners entering and clearing	58
Tons.....	1, 970
Hatches.....	72
Number of men employed.....	232

Those entering carry merchandise, returning with lumber. The local steamer carries the mail and passengers.

Very respectfully, your obedient servant,

WALTER S. DAVIS,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

From this examination it would appear that the only portion of the lower part of the river that would need improvement is at the mouth of the river in Calcasieu Lake, where an island divides the river and where a bar is formed which at times has but 5½ feet of water over it. The statistics in Mr. Davis' report show that the commerce of the river is of very considerable importance, and that the improvement at the mouth would probably be of more benefit to the navigation interests than the improvement of any other part. A project will be submitted for the work.

The total of the amount estimated for the improvement of this river based upon the survey above Lake Charles, and providing for no work at the mouth, has been appropriated. The deepening of the channel across the bar at the mouth can probably be accomplished by the construction of about 12,000 feet of light jetty work at a cost of \$3 per foot. The amount required therefore, not yet appropriated, is \$36,000.

This work originated in an examination authorized by act of Congress approved June 14, 1880, a report of which, together with plan and estimate of cost of improvement, was published in Report of Chief of Engineers for 1881, Appendix M 15.

The work is located in the collection district of Galveston, Tex. The nearest light-house is at the entrance to Calcasieu Pass.

Original estimate for upper part of river.....	\$10,080 00
Total amount appropriated.....	10,000 00
Total amount expended	203 16

Money statement.

July 1, 1882, amount available.....	\$2,991 39
Amount appropriated by act passed August 2, 1882.....	7,000 00
	<hr/>
	9,991 39
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	194 55
	<hr/>
July 1, 1883, amount available.....	9,796 84
	<hr/>
Amount (estimated) required for completion of existing project	36,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	36,000 00

Q 15.

IMPROVEMENT OF CALCASIEU PASS, LOUISIANA.

No work was done during the year. The amount available is \$3,000. This amount is too small to warrant the commencement of any new work. The appropriation made March 3, 1881, was sufficient to open a channel 7,500 feet long, 70 feet wide, and 8 feet deep, finished in February, 1882.

The extent to which this channel has since filled is not known. It is probable that it will require attention again. For the present I would not recommend any work nor any appropriation for the next fiscal year. An examination of this pass was made in 1871, report of which, with plan of improvement and estimate of cost of same, was published in Annual Report of Chief of Engineers for 1871, Appendix N 12.

The work is not considered permanent in the ordinary acceptance of the term, as the cut is liable to be gradually filled up.

1130 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

The commerce of the pass is that of the Calcasieu River, a statement of which is given in the report on that work.

The work is located in the collection district of Galveston. The nearest light-house is at the Gulf entrance of the pass.

Total amount appropriated.....	\$15,000
Total amount expended	12,000

Money statement.

July 1, 1882, amount available	\$156 75
Amount appropriated by act passed August 2, 1882.....	3,000 00
	<hr/> 3,156 75
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	156 75
	<hr/> 3,000 00
July 1, 1883, amount available	3,000 00

Q 16.

REMOVAL OF WRECK IN PASS MARIANNE, MISSISSIPPI SOUND.

The removal of this wreck was completed July 2, 1882, and payment was made to contractors July 6, 1882.

Money statement.

Allotment from amount appropriated by act passed June 14, 1880.....	\$4,031 12
July 1, 1882, amount expended	\$90 62
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	3,940 50
	<hr/> 4,031 12

Q 17.

EXAMINATION OF WEST PEARL RIVER, LOUISIANA.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 2, 1883.

GENERAL: I have the honor to transmit herewith a report of Assistant Engineer H. C. Collins, on examination of West Pearl River. The improvement of Pearl River, now in progress, includes the improvement of West Pearl below Home Bayou. It also includes the closing of the head of West Pearl where it leaves the main Pearl River. I cannot see anything to be gained under the circumstances of any further improvement of the West Pearl.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. H. C. COLLINS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., May 16, 1883.

SIR: I have the honor to make the following report of examination of West Pearl River:

West Pearl leaves Pearl River at the westerly bend 263½ miles below Jackson, Miss. Its head is now being closed by a dam with the object of keeping the water in Pearl River. It runs into a thick cypress swamp, and, joining the water of Bogue Chitto and that coming from run out bayous from the west side of Pearl River below the 249th mile, finds its way through many channels to unite with the navigated channel of Pearl River at the mouth of Home Bayou. The portion of West Pearl below this point was surveyed in 1879 and report published in the Report of Chief of Engineers for that year. The portion of West Pearl above this junction with Home Bayou will only be of use as the continuation of Bogue Chitto unless the present effort to make a channel for Pearl River by way of the old Pearl and Home Bayou should prove a failure, and it might then be found necessary to carry the Pearl down through some one of the many bayou channels between Pearl River and its western bluffs. Many years ago the State of Louisiana made an effort to open a channel through, by way of this upper West Pearl, to the upper Pearl River, but they only reached a few miles, chopping a channel among cypress stumps down to about the low-water mark, and finally abandoning it and opening or attempting to open the Home Bayou route. There is a small business done now up this channel, an occasional schooner going up it for wood, but they go but few miles and very seldom use it at all.

Should it prove impossible to carry navigation down Pearl River by the route now being tried, the only remaining thing to do will be to examine these western channels and one may possibly be found by which upper Pearl can be reached. No survey will be needed for this purpose until it is certain that the present plan cannot be a success.

Yours, respectfully,

H. C. COLLINS,
Assistant Engineer.

Maj. AMOS STICKNEY,
United States Engineers.

Q 18.

EXAMINATION OF GRAND LAKE, LOUISIANA.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 2, 1883.

GENERAL: I have the honor to transmit herewith a report of Assistant Engineer H. C. Collins on examination of Grand Lake, Louisiana. From this report it will be seen that no improvement should be attempted until the route for entering the upper end of lake has been decided upon. This question is intimately connected with the rectification of the mouth of Red River and the Atchafalaya, now under consideration of the Mississippi River Commission.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. H. C. COLLINS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., May 18, 1883.

SIR: I have the honor to make the following report on Grand Lake, Louisiana:

Grand Lake is a large shoal lake which forms part of the channel of the Atchafalaya on its way to the Gulf. The navigated channel from the Atchafalaya enters through Chicot Pass, which is very deep, and shoals on the bar at its mouth to about 3½ feet at extreme low water of a northerly gale, but is not, except when the water is driven out by a gale, less than 4 feet in depth. The navigation of this upper part of the lake is obstructed for about 6 miles by old logs, drift-piles, and old raft, sunken

and buried under sand and mud. Bayou Pigeon enters on the left bank nearly 12 miles below the head of the lake, and directly opposite the Grand Lake end of Charenton Canal line.

There is also a channel from Bayou La Rompe down Bayou l'Embaras and Faussee Point Lake to the head of Grand Lake. This has at times been used at the lowest stages of water as a route for steamers from Grand Lake to the Atchafalaya.

There is a connected network of bayous along the upper end and east side of Grand Lake, which are all navigated by swamp-boats to bring out cypress timber. The lake is about 35 miles long and 10 miles wide at its widest place. The banks are nearly all cypress swamp to the water edge; through them are shell banks, on Shaw's Island, near the upper end of the lake, and at Indian Bend, nearly south of it, and many other smaller ones along the shore. The high water was formerly, before the enlargement of the Atchafalaya, about 4 to 5 feet above low water, but at its head it was 15 feet above low water in 1882, and more than 10 feet above at its lower end. The channel for discharge through Berwicks Bay does not appear to have enlarged its cross-section since 1760. Many former channels for discharge are entirely closed, and, from Bayou Lafourche on the eastward to Bayou Salle on the west, Morgan's Louisiana and Texas Railroad forms a dam with only a few small openings, except that at Morgan City over Berwicks Bay, which retains the waters of a flood until they rise to such height that they can be discharged through Berwicks Bay and the few other openings left by the road. In the flood of 1882 the right bank of the Teche was practically the bank of the lake, and below Bayou Salle the railroad embankment was the bank. There were a few narrow portions of the left bank of the Teche above water, but except these Grand Lake covered the entire valley to the bank of the Mississippi and Lafourche. The bayou channels entering the lake from the upper Atchafalaya are too small to carry the water brought down from above and their banks are low; in this flood they were covered from 15 to 25 feet. A thick growth of willows prevents the cutting out of these bayous between Grand River and Grand Lake. These banks were formerly cultivated sugar fields and above all overflow before the enlargement of the Atchafalaya. Now these are covered every year, and are covered with a dense growth of willow. The channel of Grand Lake is said to be less obstructed by logs than formerly, and steamer captains say it is deeper, particularly at Cypress Island Pass, and from there to the head of lower Atchafalaya. The bottom of the lake is blue clay, except at the upper end of the lake, where soft bottom is found. The water at low stage is brackish, and barnacles, gnathodon clams, and sea crabs are found, but no teredo is found even in the lower end of the lake.

There was a saw-log harbor made in 1860, or before, by driving piles out into the lake for about 1,000 feet, making a square pen. Many of these piles were evidently refuse logs, hollow, &c., but some were good sound cypress. All are good as ever below water line, and the good heart cypress piles are now sound to their tops, and appear able to last for twenty-three years more. Cypress, which is found in such great quantities, is the only kind of timber found here which will last when exposed to air and water alternately, as these piles have been. The shoal water due to raft formation is confined to the upper part of the lake, not reaching more than 8 miles down the lake from Chicot Pass. Improvement in the channel of Grand Lake would be confined to deepening the channel across the log bar at its head. This bar, at the mouth of Chicot Pass, is already far better than the channel through Lakes Chicot and Mongolois and their bayou connections with Grand River. Should Bayou Plaquemine be opened for navigation, the Teche boats would find their route down Grand River to Bayou Pigeon, and through it to Grand Lake, avoiding all the bad upper end of Grand Lake and all of Lake Chicot, at cost of clearing lower Grand River and Bayou Pigeon, which would be far less, and would enter just opposite Charenton Canal and entirely below the shoals at the head of the lake. Should the present Atchafalaya route be continued, the improvement of the worse portions of the channel should precede this of the lake. Opening Bayou Plaquemine would reduce cost of transporting freight to New Orleans to very nearly half its present rate, and so increase amounts shipped and number of boats passing. All coal used on lower Atchafalaya and Teche is towed down through Grand Lake. All cypress for use there as fencing, lumber, and shingles, and a very much greater amount sawed at the lower Atchafalaya mills, is shipped by schooners to Texas and Mexico from Morgan City. The sugar, cotton, and stock raised along the Teche and sent by water to New Orleans also passes this way, and the rate of freight on all raised and carried over railroads as well, is established by cost of carriage by the water route; so that reduction of this cost would be just so much help to a large number of worthy citizens who have been greatly injured within the past few years by floods from the enlarging of Atchafalaya.

Yours, respectfully,

H. C. COLLINS,
Assistant Engineer.

Maj. AMOS STICKNEY,
United States Engineers.

Q 19.

EXAMINATION OF BOGUE CHITTO, MISSISSIPPI AND LOUISIANA.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 2, 1883.

GENERAL: I have the honor to transmit herewith a report of Assistant Engineer H. C. Collins on examination of Bogue Chitto. From this report it will appear that no improvement can be made except at a cost entirely incommensurate with benefits to be obtained.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. H. C. COLLINS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., May 16, 1883.

SIR: I have the honor to make the following report of examination of Bogue Chitto.

Bogue Chitto rises in the southern part of the State of Mississippi, and runs to the southeastward, crosses the State line into Washington Parish, Louisiana, about midway between Pearl River and the Tangipahoa, and finally enters Pearl River at the lower end of Home Bayou by way of the upper West Pearl.

It runs in a very direct valley, bordered by low bluffs, through a region of high pine hills. This valley varies from one-fourth of a mile to rather more than a mile in width. The tributary streams nearly all enter from the left bank, from valleys among the pine hills, these alternate ridges and valleys running nearly north and south. The rainfall of the region is very great, and the valley is frequently covered with a flood from 5 to 15 feet deep for the whole width of the level bottom land. At such times the water flows directly down the valley, but in this wide bottom is a channel 50 to 100 feet in width, cut down 10 to 20 feet below the general level of the bottom land, and winding through it in a very crooked course, reaching the bluffs at most of its alternate great bends, but full of sharp minor curves as it passes from one bluff to the other. The bottom land is covered with a heavy growth of large gum and hardwood trees and a dense undergrowth of bushes, small trees, vines, and cane.

I could see no appearance of washing of the bottom land surface to any great extent, and there now appears to be a far greater average fill from sand washed in from tributaries and deposited on the bottom land than the cut made at a few spots. But a small proportion of the whole country is in cultivation, and where it is cultivated the wash from the surface is very great. This all finds its way into the bottom land, and does not appear to fill the deep low-water channel, but to be deposited among the undergrowth of the valley level lands. This undergrowth causes the flood current to be very much less than that which is found in the channel when floods are just within the banks.

Inhabitants say that the low-water channel is very much obstructed by old trees, snags, &c., and that there are frequent piles of drift reaching several feet above the low-water level. The low-water banks are nearly vertical in most places, and do not appear to wash or cave to any great extent. The bottom land has a loose, sandy soil, and any great increase of current would be at once followed by a proportionate increase in washed banks. An improvement, to the extent of removing all obstructions, would need to be continuous for many years, and would probably only end when all the bottom land timber had been washed in and removed, leaving the channel in the end a succession of sand and gravel bars and deep pools. Should commerce ever justify the cost of a thorough improvement, dams and slackwater navigation would be more easily made while the low-water channel retains its present steep banks and uniform cross-section than after it should have reached the condition of wide sand flats, and cut-offs should have formed in every bend, which would be the probable effect of thoroughly removing all obstructions from the bed and of keeping it clear for very many years.

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A slight clearing, which would enable steamers to run on the river, with a 5-foot rise, and which would make it possible to run out saw-logs, with a rise of 5 feet, might not do very much damage to the banks. The inhabitants say that very long ago keel-boats were used to bring in supplies, but keel-boat navigation was long ago abandoned, and now pine saw-logs are floated down to the mills on Pearl River. These are taken at the end of floods, when the water has fallen so low that there is no longer risk of their passing over the bank into the lower bottom lands, and while there is yet sufficient water to keep them well above obstructions.

Bogue Chitto formerly entered Pearl River 54 miles above the Rigolets, but it has changed its channel to enter West Pearl, and with that stream it joins the present navigated channel at the lower end of Home Bayou, 21 miles below. The old channel at its entrance into Pearl River is closed at low water by sand bar, and for about 3 miles up to where the old channel is now abandoned by the stream for the west side bayous it is rapidly growing over. It is no longer used by raftsmen.

Yours respectfully,

H. C. COLLINS.

Maj. AMOS STICKNEY,
United States Engineers.

APPENDIX R.

IMPROVEMENT OF RED RIVER AND RIVERS IN LOUISIANA AND ARKANSAS—IMPROVEMENT OF CERTAIN RIVERS IN MISSISSIPPI AND TENNESSEE TRIBUTARY TO THE MISSISSIPPI—WATER-GAUGES ON THE MISSISSIPPI AND ITS PRINCIPAL TRIBUTARIES.

REPORT OF MAJOR A. M. MILLER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|---|--|
| 1. Red River, Louisiana. | 10. Yallabusha River, Mississippi. |
| 2. Removing raft in Red River, and closing Tone's Bayou, Louisiana. | 11. Big Hatchee River, Tennessee. |
| 3. Removing obstructions from Red River, Louisiana. | 12. South Forked Deer River, Tennessee. |
| 4. Upper Red River, from Fulton, Ark., to the head of the raft. | 13. Ouachita River, Arkansas and Louisiana. |
| 5. Yazoo River, Mississippi. | 14. Bayou Bartholomew, Louisiana and Arkansas. |
| 6. Big Sunflower River, Mississippi. | 15. Tensas River, Louisiana. |
| 7. Tallahatchee River, Mississippi. | 16. Boeuf River, Louisiana. |
| 8. Coldwater River, Mississippi. | 17. Cypress Bayou, Texas and Louisiana. |
| 9. Tchula Lake, Mississippi. | 18. Water-gauges on the Mississippi River and its principal tributaries. |
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UNITED STATES ENGINEER OFFICE,
MEMPHIS, TENN., *July 14, 1883.*

GENERAL: I have the honor to transmit herewith annual reports upon the works of river and harbor improvements under my charge for the fiscal year ending June 30, 1883.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

R 1.

IMPROVEMENT OF RED RIVER, LOUISIANA.

The three preceding items of improvement—removing raft in Red River and closing Tone's Bayou, Louisiana, removing obstructions from Red River, Louisiana, improvement of Upper Red River from Fulton, Ark., to head of raft—were combined under the above heading in the river and harbor act of August 2, 1882, and it now includes the improvement of the whole river from the mouth of the Atchafalaya to Fulton, Ark.

The new iron snag-boat C. W. Howell was fitted out for work on Red River, and left Memphis, September 3, 1882, arriving at mouth of Red River September 8. It was intended to employ her in the removal of snags, &c., between Shreveport and the mouth of the Atchafalaya. She had been provided with a new wheel, with a hollow iron shaft, built up by riveting together sheets of wrought iron, in the form of a cylinder. The shaft was found to be essentially defective, the rivets constantly shearing off and working loose, requiring continual repairs, until finally, on October 24, 1882, the shaft gave way entirely, and the wheel became a total wreck. She was towed by the United States steamer Thomas B. Florence to Shreveport, arriving there November 6, and an entire new wheel, with solid shaft and wooden arms, put in her. This wheel was completed January 14, 1883, and the *Howell* was then employed on the upper river from January 24 until March 9, when she was laid up at Shreveport on account of high water.

In the mean time authority had been obtained to employ the United States snag-boat John R. Meigs, upon the completion of her season's work in Yazoo River, to replace the *Howell* on Red River, and she worked up-stream as far as Shreveport removing obstructions, arriving at Shreveport December 13, 1882, when she was withdrawn from the Red River and laid up.

The United States steamer Thomas B. Florence was employed in the Upper Red River during the whole fiscal year, removing jams, snags, &c., in the Raft region and maintaining uninterrupted navigation in this portion of the river.

On September 30, 1882, bids were opened for the removal of rock from the bed of the Red River, at the falls in the vicinity of Alexandria, La.

The following is an abstract of bids received:

No.	Names of bidders.	Price.	Remarks.
1	Willard Johnson, Fulton, Oswego County, N. Y.	<i>Per cu. yd.</i> \$10 93	All proposals more or less informal.
2	Edward P. Doherty, New Orleans, La.	3 45	

The contract was awarded to Edward P. Doherty, of New Orleans, La., he being the lowest responsible bidder. Owing to continuous high water no work has been accomplished under this contract. An assistant has been employed laying out the channel to be excavated and taking soundings to verify the amount of material removed.

The amount of work done in Red River below Shreveport is as follows:

BY SNAG-BOAT C. W. HOWELL.

Snags pulled.....	216
Trees cut down.....	302

BY SNAG-BOAT JOHN R. MEIGS.

Snags pulled.....	120
Trees cut down.....	3,325
Shore snags removed.....	37
Side jams broken up.....	3

Amount of work done in Red River above Shreveport is as follows:

BY SNAG-BOAT C. W. HOWELL.

Snags pulled.....	227
Trees cut down.....	337
Shore snags removed.....	15
Side jams broken up.....	10
Logs removed.....	4

BY STEAMER THOMAS B. FLORENCE.

Snags pulled.....	375
Trees cut down.....	5,456
Willow points cut off.....	86
Shore snags removed.....	1,297
Jams and side jams broken up.....	107
Logs removed.....	106

By direction of the Chief of Engineers an examination of Bayou Pierre, with a view to removal of the raft therein, was made in March, 1883, and report forwarded April 11, 1883.

During the coming season it is proposed to complete the work on the falls at Alexandria, and the snag-boat Howell will work in the lower river and the steamer Florence in the upper river as long as the available balance will permit.

No detailed estimates will be presented for the improvement of Red River, since the nature of the work must be continuous from year to year, owing to the character of the obstructions which each flood brings down.

The former appropriations for the improvement of Red River are as follows:

Under the head of removing raft in Red River and closing Tone's Bayou, Louisiana.....	\$419,500
Under the head of removing obstructions from Red River, Louisiana.....	117,500
Under the head of improving Upper Red River from Fulton, Ark., to head of raft.....	20,000
For the whole of Red River, by act passed August 2, 1882.....	75,000

COMMERCIAL STATISTICS.

Shreveport, La., is the principal city on Red River, and it contains a population of 12,000 inhabitants, and the following are its commercial statistics:

Number of steamboats running to Shreveport.....	20
Cotton.....	bales.. 108,000
Cotton-seed.....	tons.. 3,200
Cotton-seed meal.....	sacks.. 6,700
Cotton-seed cakes.....	pounds.. 20,630
Cotton-seed oil.....	barrels.. 6,000
Hides.....	pounds.. 270,000
Wool.....	do.. 87,000
Tallow.....	do.. 18,000
Bees'-wax.....	do.. 5,500
Junk.....	do.. 200,000
Lumber.....	feet.. 35,000,000

The following are the commercial statistics of the whole of Red River:

Cotton.....	bales.. 160,440
Cotton-seed.....	tons.. 18,000
Hides.....	bales.. 600
Cotton-seed oil.....	barrels.. 9,000
Staves.....	400,000
Cattle.....	3,000
Hogs.....	5,000
Ash wood.....	cords.. 40,000
Value of return freight, &c.....	\$2,000,000

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Money statement.

July 1, 1882, amount available:

From appropriation for removing raft in Red River and closing Tone's Bayou, Louisiana	\$24,420 71
From appropriation for removing obstructions from Red River, Louisiana	1,446 76
From appropriation for improvement of Upper Red River, from Fulton, Ark., to head of raft	2,874 19
Amount appropriated by act passed August 2, 1882	75,000 00
	<u>103,741 66</u>

July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882:

From appropriation for removing raft in Red River and closing Tone's Bayou, Louisiana	\$7,854 69
From appropriation for removing obstructions from Red River, Louisiana	1,446 76
From appropriation for improvement of Upper Red River, from Fulton, Ark., to head of raft	2,874 19
From appropriation for improvement of Red River, Louisiana	36,466 59
	<u>48,642 23</u>
July 1, 1883, outstanding liabilities	40,000 00
	<u>88,642 23</u>
July 1, 1883, amount available	15,099 43
Amount that can be profitably expended in fiscal year ending June 30, 1885	<u>75,000 00</u>

R 2.

REMOVING RAFT IN RED RIVER AND CLOSING TONE'S BAYOU, LOUISIANA.

I assumed charge of this work June 30, 1882, by virtue of Special Orders No. 125, paragraph 2, Adjutant-General's Office, Washington, D. C., May 31, 1882, relieving Maj. W. H. H. Benyaure, Corps of Engineers, United States Army.

The appropriation for this improvement in the last river and harbor act was included with the others pertaining to the Red River under one general head, with the title, Improving Red River, Louisiana. The report of work done for the season will therefore be found in the report under that head.

The balance remaining unexpended was used in conjunction with the appropriation for improving Red River.

The appropriations for removing raft and closing Tone's Bayou, Louisiana, have been as follows:

By act approved June 10, 1872, for removing raft	\$150,000 00
By act approved March 3, 1873, for removing raft	80,000 00
By act approved June 23, 1874, for removing raft	50,000 00
By act approved March 3, 1875, for removing raft	20,000 00
By act approved August 14, 1876, for removing raft and closing Tone's Bayou	35,000 00
Allotment August 27, 1877, for closing Tone's Bayou	4,500 00
By act approved February 7, 1878, for removing raft	6,000 00
By act approved June 18, 1878, for both	24,000 00
By act approved March 3, 1879, for both	15,000 00
By act approved June 14, 1880, for both	25,000 00
By act approved March 3, 1881, for both	10,000 00
Amount expended to June 30, 1882	<u>395,079 29</u>

Money statement.

July 1, 1882, amount available.....	\$24,420 71
Amount accounted for in money statement for improvement of Red River, Louisiana.....	24,420 71

EXAMINATION OF BAYOU PIERRE, LOUISIANA.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., April 13, 1883.

GENERAL: In accordance with directions contained in letter dated Office of the Chief of Engineers, United States Army, Washington, D. C., February 3, 1883, I have the honor to submit the following report on an examination of Bayou Pierre, Louisiana, and estimate of cost of removing raft from same.

The examination was made by Mr. Joseph Burney, assistant engineer, between February 27 and March 19, 1883. Owing to the high stage of water the bayou was in an unfavorable condition to make as accurate an estimate as desirable. It is estimated that the removal of the raft will cost \$100,000.

This work would necessitate an entire change in the project for the improvement of navigation of the Red River between Tone's Bayou and Bayou Winsey, as it is not probable that enough water would be available, should the raft be removed, for navigation of Red River at low water between those points. On this account it is highly desirable that an accurate survey of Bayou Pierre should be undertaken, if it should be decided to remove the raft therein.

In a report to the Engineer Department on this subject, dated December 29, 1882, I submitted an estimate for the survey of Bayou Pierre; the estimate of cost was \$8,646.

The report of Mr. Burney is submitted herewith.

Very respectfully, your obedient servant,

A. M. MILLER,
Captain, Corps of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. JOSEPH BURNEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., April 7, 1883.

CAPTAIN: I have the honor to report that, in accordance with your instructions, I have made an examination of Bayou Pierre, State of Louisiana, with a view to the removal of the raft in the bayou and for the improvement of navigation on Red River.

I left Shreveport, La., in a skiff, accompanied by two skiffmen, passed through Tone's Bayou, examined the broken dams, and through Bayou Pierre, Lake Cunnissnia, Prairie River, Bayou Winsey, and Red River, to Campte, a distance of 240 miles, whence we returned to Shreveport by steamboat. During my inspection the water was at a high stage and I could not make so thorough an examination as at extreme low water; but I was stationed in that district for nearly two years acting under the direction of Major Benyaud, Corps of Engineers, United States Army, and am therefore familiar with the country.

The opening of Bayou Pierre route has long been under consideration, and it is a very important question to the steamboat interests and the land-owners living in the vicinity. Many eminent engineers have reported against opening the Bayou Pierre route and a large amount of money has been expended in attempting to turn the water, at present wasted through Bayou Pierre, into Red River.

About ten years ago the State of Louisiana attempted to close Tone's Bayou, but failed. At a later date the United States Government opened a channel through the upper raft above Shreveport and turned all the drift into Tone's Bayou, with a view to close it; the drift was secured by chains and piles, but broke loose, when it ran into Bayou Pierre and jammed, there being no outlet below for the drift. Each year the raft is becoming greater, spreading out over the plantations, which have to be abandoned. Another attempt was made by the United States Government to construct a tumbling dam of piles and stone; this was carried away by the water. Another attempt was made to construct a dam of willow brush, sacks filled with clay and stone; this met with partial success, but was eventually destroyed. The last attempt was made to construct a very heavy embankment of earth-work; this dam was nearly completed, which caused a serious and damaging overflow, for about 30 miles above the dam; the drift began spreading out over the plantations and cutting new channels across the land in various directions. The citizens took forcible possession of the Government works and destroyed them; twelve hours after the dam was cut the water fell 3 feet at Shreveport, a distance of 30 miles above, and in the vicinity of the dam 8 feet. In twenty-four hours the plantations above were free from overflow.

The overflow was caused by attempting to force such a large body of water down Red River, which has a very crooked channel below Tone's Bayou, part of the channel running through stiff buckshot clay, not susceptible to scour and enlargement, to accommodate the increased body of water directed down it. This channel has never carried the water passing Shreveport, over two-thirds of the water being carried by numerous bayous into Bayou Pierre, and returned to Red River about 120 miles below.

It is claimed by engineers and steamboatmen, that if the water is allowed to be wasted down Bayou Pierre, the navigation to Shreveport, will be suspended; this I believe to be true, for a sand-bar will form below Scopini's "Cut-off" and force all the water into Bayou Pierre.

In order to prevent the suspension of navigation, two plans can be adopted. The first is to stop the water running through Tone's Bayou and Bayou Pierre and force it into Red River. The second, to remove the raft and make the navigable channel through Bayou Pierre.

The river from the lower mouth of Bayou Pierre to 45 miles above Shreveport is known as the raft region, and there was no navigable channel over this portion of Red River until one was made by the State of Louisiana and the United States Government. This channel is only now kept open by the constant vigilance of the United States engineers. I estimate for the last ten years the United States Government has expended for this purpose over \$500,000, being an average annual cost of \$50,000.

About twenty-five years ago the State of Louisiana and the United States Government cut a channel through the lower raft, choosing one of the many channels available for that purpose, and now known as Red River. Immediately after the removal of the raft the city of Shreveport was built, and the river formed the only means of transportation for North Louisiana and Eastern Texas. In order to improve navigation, the State of Louisiana made Scopini's Cut off; this was made through stiff blue clay, not susceptible to scour, and in order to force the water through the "Cut-off," a dam was constructed across Old River. This entirely failed of the purpose, for immediately above the dam was a small bayou, about 2 yards wide, running into Bayou Pierre, offering less resistance than the "Cut-off," and which rapidly enlarged and wasted the water through Bayou Pierre.

Attempt after attempt has been made to close Tone's Bayou, but up to date has entirely failed, and now it is draining over two-thirds of the water, and will shortly destroy low-water navigation.

The country above Shreveport becoming rapidly settled, a demand was made on the United States Government to open out the upper raft. To this they consented, and the work was done at a cost of about \$300,000. This work greatly added to the value of land above the raft, draining a large section of rich cotton lands and allowing many thousands of acres subject to overflow before raft was removed to be cultivated.

A large amount of driftwood annually comes from Upper Red River, and is kept from again forming a raft by the United States steamer Thomas B. Florence, which breaks up the jams and keeps the drift floating below Shreveport. I estimate that 5 miles of floating drift passes down and becomes jammed in Bayou Pierre, there being no outlet below. For the last ten years this raft has been steadily increasing each year, damming up the channel, cutting out new chutes, spreading the drift in all directions, so that plantation after plantation has been abandoned.

The head of the raft is now about 5 miles from the entrance to Tone's Bayou, and will in a few years be up to it.

I estimate that if the raft is not removed and the drift run out of Red River into the Mississippi River, in twenty-five years every plantation above Tone's Bayou to Shreveport will be destroyed on both sides of the river and the navigation entirely suspended.

The planters in the vicinity are fully aware of this, and are greatly discouraged; many are moving away and abandoning their homes, while others, at a great expense, are building levees to prepare for the increased height of water. I met a number of planters on my inspection, and they feel greatly injured by the work done by the United States Government. They stated that they had opened out their plantations when the raft above Shreveport was closed and no drift came down the river, and the escape of water through Bayou Pierre caused them no injury, but the Government has opened out the raft above Shreveport, which has been of very great benefit to navigation and to the land-owners above the raft.

The raft if left to itself would soon reform and relieve them of the drift, but the Government keeps a steamboat breaking up the jams and floating down the drift upon their property, completely destroying their plantations for the benefit of others. This they believe to be illegal and against the Constitution of the United States, which states that no man's property shall be taken for public use without just compensation, and they consider they should either be paid for their property destroyed, or the Government should open out Bayou Pierre, which is the natural channel of Red River, and keep the drift moving out into the Mississippi River. I informed them that my inspection was only with a view to benefit navigation, but I would report their statements to you for such action or recommendation as you might deem necessary.

In order to keep the river open to navigation, some plan will have to be adopted and executed at an early date, or the water will all be wasted through Bayou Pierre.

As I before stated, two plans can be adopted:

First, the closing of Tone's Bayou. This has proved a very difficult, and up to date unsuccessful, work. I estimate that over \$100,000 has been expended, and lost, in the attempt. In closing this bayou, we are compelling the water to abandon the route it naturally seeks, and force it to run on a high ridge, through a crooked channel, the distance being twice as long as through Bayou Pierre. Assuming that Tone's Bayou was effectually closed, the result would be a temporary benefit to navigation, but not permanent; the water would be backed up to Shreveport and open out the upper entrance to Bayou Pierre. When Tone's Bayou was a very small stream, the upper entrance to Bayou Pierre was very large and carried a large quantity of water, but as Tone's Bayou grew larger, the entrance to Bayou Pierre gradually closed. If Tone's Bayou was closed, I believe the upper entrance to Bayou Pierre would soon regain its former dimensions and the loss of water simply transferred to that point. Should this channel also be closed, there are numerous high-water channels running into Bayou Pierre through soil very susceptible of scour, which would enlarge and still carry off the water. When the last dam was nearly completed, a new channel, about 3 miles above Tone's Bayou, commenced rapidly scouring out, and had the dam stood, in all probability a new entrance would have been made in that location.

Another serious danger to the work, in closing Tone's Bayou, is the open hostility shown by the citizens in the neighborhood. I have always found them generous, hospitable, and law-abiding, but in this case they hold the Government has no right, without paying damages, to injure their property for the benefit of others, and they consider they have a legitimate right to destroy the works, and would be sustained by the United States courts.

Should a new dam be constructed it will require a strong armed guard to protect it, the year round; even then I believe the citizens will fight and many valuable lives lost in its defense and for its destruction.

The second plan is the opening out of the Bayou Pierre route. In this work, instead of opposing the natural inclination of the water, we would have its valuable assistance.

In my inspection the water was very high, and I could not make so thorough an examination as at extreme low water, but I saw nothing that could not be removed, and a good, navigable channel made. I have read carefully over the report of an examination made during low water by the late Mr. George R. Wilson, assistant engineer. (See Chief of Engineers' Report for 1879, Part II, page 993, *et seq.*) While he is opposed to opening the Bayou Pierre route, he reports that it can be done at a cost of \$175,000. If this route is opened the driftwood will seek this channel and run out into the Mississippi River. So long as this drift has no outlet out of Red River, it will be very destructive to property and a standing danger to navigation, and in time entirely suspend it.

By opening out Bayou Pierre route the permanent navigation of Red River will be secured, and the only attention it will require will be the same as the other tributaries of the Mississippi River, namely, the removal of snags, &c.; it will not only secure good navigation but reduce the high water as far up as Shreveport and make

the costly expense of levees unnecessary and reclaim thousands of acres of the richest cotton lands in the country, which would be immediately put under cultivation; it would change the surrounding country from its gloomy desolation, avoided by man and beast, and convert it into farms and plantations, inhabited by a happy and prosperous people. I have been engaged at various times on this portion of the river, for a period extending over seven years, and have given the subject very careful consideration, and I respectfully recommend that no attempt be made to close Tone's Bayou, as the water would easily find another inlet above; and I recommend, that the raft be removed and the navigable channel be made through Bayou Pierre until it enters Bayou Winsey or its lower outlet.

I estimate the work to cost \$250,125, of which the following is a detailed estimate:

ESTIMATE FOR MAKING NAVIGABLE CHANNEL FROM MOUTH OF BAYOU WINSEY TO THE ENTRANCE OF TONE'S BAYOU.

From the mouth of Bayou Winsey to Gravelly Point:	
25,000 cubic yards excavation, at 50 cents.....	\$12, 500
Removal of snags	2, 500
Clearing 300 acres, at \$20.....	6, 000
From Gravelly Point to entrance of steamboat channel:	
40,000 cubic yards excavation, at 40 cents.....	16, 000
From steamboat channel to Round Lake:	
70,000 cubic yards excavation, at 50 cents.....	35, 000
75 acres clearing, at \$20	1, 500
From lower entrance to Lake Cunnissnia to entrance to Tone's Bayou:	
35,000 cubic yards excavation, at 40 cents.....	14, 000
Removal of raft	100, 000
60,000 cubic yards embankment for training walls and closing high-water channels, at 50 cents	30, 000
	<hr/>
	217, 500
Engineering contingencies, &c., 15 per cent.....	32, 625
	<hr/>
Total cost	250, 125

A very large amount of business is done on the river. Shreveport contains about 10,000 inhabitants. Jefferson, Tex., contains about 6,000 inhabitants, and I estimate fully 50,000 people export their produce and receive their supplies by this route, and I think the business done fully justifies the expenditure of the money required for the improvement of navigation.

Before undertaking a work of this importance, a thorough topographical survey should be made from Shreveport connecting with the survey of the upper raft, made under the direction of the late Maj. C. W. Howell, Corps of Engineers, United States Army, down to the lower mouth of Bayou Pierre.

The survey should cover the present route down Red River and the proposed route through Bayou Pierre. This work could be done during the present low-water season, when you would be able to forward such report as you desire to make, to lay before the next sitting of Congress.

I estimate the survey to cost \$10,000.

I have the honor to remain, very respectfully,

JOSEPH BURNBY.

Capt. A. M. MILLER,
Corps of Engineers, U. S. A.

R 3.

REMOVING OBSTRUCTIONS FROM RED RIVER, LOUISIANA.

I assumed charge of this work June 30, 1882, by virtue of Special Orders No. 125, paragraph 2, War Department, Adjutant-General's Office, Washington, D. C., May 31, 1882, relieving Maj. W. H. H. Benyaud, Corps of Engineers, United States Army.

The appropriation for this improvement was included in the last river and harbor act, with the others pertaining to the Red River, under one general head, with the title, "Improving Red River, Louisiana."

A small balance of the old appropriations remained on hand at the time of transfer, and this amount was expended in purchasing outfit for the iron-hull snag-boat, built out of the appropriations for this improvement.

The former appropriations are as follows:

By act approved June 18, 1878.....	\$25,000 00
By act approved March 3, 1879.....	22,500 00
By act approved June 14, 1880.....	60,000 00
By act approved March 3, 1881.....	10,000 00
Amount expended to June 30, 1882.....	116,053 24

Money statement.

July 1, 1882, amount available.....	\$1,111 73
Amount accounted for in money statement for improvement of Red River, Louisiana.....	1,446 76

R 4.

IMPROVEMENT OF UPPER RED RIVER FROM FULTON, ARKANSAS, TO
THE HEAD OF THE RAFT.

I assumed charge of this work June 30, 1882, by virtue of Special Orders No. 125, paragraph 2, War Department, Adjutant-General's Office, Washington, D. C., May 31, 1882, relieving Maj. W. H. H. Benyard, Corps of Engineers, United States Army.

This improvement was combined, at the recent session of Congress, with the others pertaining to Red River, under one head, with the title, "Improving Red River, Louisiana," and the appropriation for the continuance of the improvements was made under that head.

The balance remaining unexpended was used in conjunction with the appropriation for improving Red River, Louisiana, and the report of work done for the season will be found under that head.

The former appropriations are as follows:

By act approved March 3, 1879.....	\$10,000 00
By act approved June 14, 1880.....	10,000 00
Amount expended to June 30, 1882.....	17,125 81

Money statement.

July 1, 1882, amount available.....	\$2,874 19
Amount accounted for in money statement for improvement of Red River, Louisiana.....	2,874 19

R 5.

IMPROVEMENT OF YAZOO RIVER, MISSISSIPPI.

I assumed charge of this work June 30, 1882, by virtue of Special Orders No. 125, paragraph 2, War Department, Adjutant-General's Office, Washington, D. C., May 31, 1882, relieving Maj. W. H. H. Benyard, Corps of Engineers, United States Army.

Having been informed by Capt. T. H. Handbury, Corps of Engineers, that he would have no use for the *Meigs*, which had been transferred to him after the close of operations the previous season, appli-

cation was made to have the boat returned to this district, for use in Yazoo River.

The authority being granted, the boat was immediately sent from Newport, Ark., where she had been laid up, to Memphis, to receive some necessary repairs and outfit, and was then sent to Yazoo River, where she arrived October 7, 1882.

The work of removing the snags and other obstructions was continued until November 15, when the appropriation being nearly exhausted, the boat was withdrawn from the stream.

The following is the amount of work done for the season :

Snags removed	472
Shore snags destroyed.....	73
Trees cut down	485

No appropriation having been made for the continuance of the work during the coming season, no work will be done. With the appropriation asked for for the fiscal year ending June 30, 1885, the snagging operations will be continued.

This work is not of a permanent character; new obstructions caused by floods, caving banks, &c., are brought into the stream each year, which are required to be removed in order to improve navigation.

The estimated cost of running a snag-boat in the river for eight months' work and for repairs is \$20,000.

The former appropriations are :

By act approved March 3, 1873, applied to the removal of eleven wrecks sunk in the stream during the late war	\$40,000 00
By act approved March 3, 1875	12,000 00
By act approved August 14, 1876	15,000 00
By act approved June 18, 1878	25,000 00
By act approved March 3, 1879	15,000 00
By act approved June 14, 1880	12,000 00
By act approved March 3, 1881	6,000 00
By act passed August 2, 1882	8,000 00
Amount expended to June 30, 1882	124,693 69

COMMERCIAL STATISTICS.

The Yazoo River traverses one of the richest sections of country in the South. Four steamers, of about 1,500 tons each, and drawing 2 feet of water, are engaged during the whole year on this river. Besides this, the boats navigating the Sunflower, Tallahatchee, and other tributaries, pass up and down this stream.

Cotton	bales..	45,000
Cotton-seed	sacks..	50,000
Staves	number..	20,000
Return freight (estimated)		\$1,200,000

Money statement.

July 1, 1882, amount available	\$306 31
Amount appropriated by act passed August 2, 1882	8,000 00
	<hr/>
	8,306 31
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	8,005 13
	<hr/>
July 1, 1883, amount available	301 18
	<hr/>
Amount that can be profitably expended in fiscal year ending June 30, 1885	24,000 00

R 6.

IMPROVEMENT OF BIG SUNFLOWER RIVER, MISSISSIPPI.

I assumed charge of this work June 30, 1882, by virtue of Special Orders No. 125, paragraph 2, War Department, Adjutant-General's Office, Washington, D. C., May 31, 1882, relieving Maj. W. H. H. Benyaurd, Corps of Engineers, United States Army.

The operations during the season consisted in the removal of snags, leaning trees, and other obstructions to navigation.

For this purpose a party was organized, using last season's camping outfit. Operations commenced on August 26 at mouth of Hushpuckina Creek and continued up-stream until Clarksdale, Miss., was reached, November 10. This being the head of navigation in Big Sunflower at high water, and there still being quite a balance left unexpended, when this point was reached the party was transferred to Standing Stump, a distance of 100 miles below Hushpuckina Creek. They worked from there up to Hushpuckina, which point was reached during the latter part of January; the party was then taken to Clarksdale, where it was disbanded January 31, 1883.

The leaning timber has now been cut down from the mouth of Clarksdale, Miss., and the smaller snags have also been removed. In any future work it will be necessary to have the use of steam, as the snags are so heavy and so deeply imbedded in the mud that they cannot be removed otherwise.

The following amount of work was done during the season:

Number of trees cut	20,433
Number of logs cut	1,802
Number of snags cut	1,307
Number of trees girdled	1,562
Three drift-piles, of 200 logs each, removed	600

Besides this a large quantity of smaller timber, not included in the above, was removed.

The report of Mr. John J. Barry, transmitted herewith, will give the details of the work.

During the coming season no work will be done, as no further appropriation has been made for the continuation of the work, and the balance remaining unexpended will be insufficient to even obtain the necessary outfit. With the appropriation asked for for the fiscal year ending June 30, 1885, it is proposed to fit out a boat with steam-power and continue the snagging operations in this stream.

The estimated cost of this improvement was \$66,000, and amount expended to June 30, 1882, \$30,645.38.

The former appropriations are as follows:

By act approved March 3, 1879	\$20,000
By act approved June 14, 1880	8,000
By act approved March 3, 1881	4,000
By act passed August 2, 1882	5,000

COMMERCIAL STATISTICS.

Cotton, 23,400 bales	\$1,170,000
Cotton-seed, 40,000 sacks	24,000
Cattle, 800 head	12,800
Hogs, 700 head	3,500
Miscellaneous products	125,000
Return freight (estimated)	500,000
Total	1,835,300

Money statement.

July 1, 1882, amount available.....	\$1,354 62
Amount appropriated by act passed August 2, 1882	5,000 00
	<hr/>
	6,354 62
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	4,340 54
	<hr/>
July 1, 1883, amount available.....	2,014 68
	<hr/>
Amount (estimated) required for completion of existing project.....	29,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	15,000 00

REPORT OF MR. JOHN J. BARRY, ASSISTANT ENGINEER.

MEMPHIS, TENN., *February 5, 1883.*

SIR: I have the honor to make the following report of the operations carried on under your instructions on the Big Sunflower River, Mississippi, during the season of 1882:

Having, under instructions from your office, left Memphis, Tenn., on the 23d of August, 1882, on the steamer James Lee, I arrived at Glendale, Miss., on the following day, and proceeded to Clarksdale, Miss., which is situated on the east bank of the Big Sunflower River. From there I transferred my outfit, consisting of boats, tents, and other appendages necessary to the success of the work I was to be engaged on, to the mouth of Hushpuckina, a small stream that empties into the Big Sunflower River, and derives its life to a great extent from the waters of the Mississippi, as instructed by you.

These operations were commenced, and work was continued up-stream until Clarksdale, Miss., was reached, when, under instructions from you, dated November 10, 1882, I transferred my outfit to that portion of the river intervening between Hushpuckina and Standing Stump, a distance of probably 100 miles, and worked up-stream until Hushpuckina was again reached, where some drift which had accumulated from the vast amount of timber cut had concentrated itself at two different points. This drift was caused by the water being extremely low, and an occasional rise from local rains would drift the cut timber to portions of the river where moderate bars had formed from some of nature's many causes, and then the receding waters would leave the timber on the shoal places without sufficient water to move it farther.

These drift-piles averaged in length 300 feet, and were removed by me to such an extent as to feel safe in saying that any moderate rise will carry them entirely away, thus preventing any further formation of a jam.

After removing the drift-piles, under instructions from you, I transferred my outfit and party to Clarksdale, Miss., where it was disbanded on January 31, 1883. My outfit was then shipped to Memphis, Tenn., where I arrived with it February 5, 1883.

The amount of work accomplished during the season is as follows:

Number of trees cut.....	20,433
Number of logs cut.....	1,802
Number of snags cut.....	1,307
Number of trees girdled.....	1,562
Three drift-piles, of 200 logs each, removed.....	600
	<hr/>
Total number of obstructions removed.....	25,704

The river from Hushpuckina, up-stream for a distance of 20 miles, is of a crooked nature, being full of obstructions of various descriptions. It is narrow, having only a moderate depth of water of from 1 to 2 feet, its average width being about 25 or 30 yards. After the first 20 miles are passed, you meet with what is known as Muscle Shoals. These shoals, three in number, are made of a hard substance composed of muscle shells and a slimy mud, and which together form a concrete bed in the river about a foot thick, which from constant accumulations of sediment, caused by the shallowness of the water that passes over them, are built up into what might be called "concrete bars," thus making the depth of water that passes over them average in low-water season not more than 6 or 7 inches. The length of the largest shoal is 600 or 700 yards, the other two being moderate in size, with more water passing over them.

From the shoals to Harrison's Bayou, a distance of 15 miles, the river is of the same nature as the lower portion. From Harrison's Bayou to Clarksdale, Miss., a distance of 14 miles, it is wider, with less obstructions and with a depth of water ranging from 10 to 20 feet.

From Hushpuckina to Clarksdale, Miss., steamers make no attempt at navigation

during low water, as it would be impossible for a steamer of any dimensions to navigate on the moderate amount of water that passes through its channel. The amount of obstructions removed this year, between Hushpuckina and Clarksdale, in my judgment, is all that is necessary at the present time. The obstructions that have been removed consisting, of leaning timber, logs, snags, &c., will promote the safety of high-water navigation, and there is no low-water navigation, nor will there ever be, unless water is furnished the channel by a system of locks and dams finding their nourishment from some other source.

The lower portion of the river from Hushpuckina to Faison, a distance of about 100 miles, is in much better condition, being wider and with a less number of obstructions and more depth of water. Faison is the head of navigation, being 209 miles from Vicksburg, Miss. From Faison down to the mouth of the Big Sunflower River at Yazoo River it is crooked and tortuous, but has more depth of water and is thickly settled, whereas from Faison to Hushpuckina there are very few settlements and consequently but little commerce.

From Faison to the Yazoo River there are some 350 landings. Therefore I would suggest that the improvements, if continued in the future, be carried on in the lower portion of the river, or, in other words, from the head of navigation at Faison to the mouth in Yazoo River, that portion being navigated all the year round.

The obstructions steamers have to contend with now in that portion of the river are snags and sand-bars. For the removal of snags it will be necessary to have some kind of boat with steam-power, as it would be a waste of time to try and remove them by hand-power. To improve the depth of water over the sand-bars it will be necessary to build wing-dams so as to concentrate the channel.

The country along the banks of the Big Sunflower River is noted for being the richest cotton-producing portion of the State of Mississippi, yielding with moderate cultivation a bale of cotton to the acre.

The river passes through six different counties, viz, Bolivar, Sunflower, Washington, Sharkey, Yazoo, and Coahoma. The combined population of these different counties is estimated at 20,000.

The shipments of cotton annually that find transportation through the waters of the Big Sunflower River to Vicksburg, New Orleans, and other markets, is as follows:

	Bales.
Bolivar County	3,500
Sunflower County	3,400
Washington County	4,000
Sharkey County	8,000
Yazoo County	3,500
Coahoma County	1,000

The following will show approximately the value of the products annually shipped by way of the Big Sunflower River:

23,400 bales of cotton, at \$50	\$1,170,000
40,000 sacks of cotton-seed, at 60 cents	24,000
800 head of cattle	12,800
700 hogs	3,500
Miscellaneous products	125,000
Total	1,335,300

The return freights cannot readily be estimated, as this portion of the Mississippi Valley for miles inland is furnished with supplies by the packet line that navigates the waters of the Big Sunflower.

There are also vast quantities of timber, principally cypress, rafted every year, and millions of staves are made along its banks and boated to New Orleans.

When the river is in a thorough navigable condition in the lower portion, steamers would make quicker time, thus reducing their expenses, which would have a corresponding effect on the up-river freights and the return produce of the country.

The leaning timber has all been cut on the Big Sunflower from its mouth to Clarksdale, Miss., the head of high-water navigation, but there are numerous snags which are dangerous to navigation and which should be removed. The snags removed this year were all of a moderate size, and I found it next to impossible to remove any of the heavier ones without the aid of steam.

There was a vast quantity of small timber cut, of which there was no record kept, yet it required both considerable time and labor, and it is as necessary that it should be cut, to the successful navigation of the stream, as the larger timber.

Very respectfully,

Capt. A. M. MILLER,
Corps of Engineers, U. S. A.

JOHN J. BARRY.

R 7.

IMPROVEMENT OF TALLAHATCHEE RIVER, MISSISSIPPI.

I assumed charge of the work June 30, 1882, by virtue of Special Orders No. 125, paragraph 2, War Department, Adjutant-General's Office, Washington, D. C., May 31, 1882, relieving Maj. W. H. H. Benyaurd, Corps of Engineers, United States Army.

The act making appropriation for this stream this year provided that the funds should be expended between Batesville and the mouth of Coldwater.

Last season, after the close of operations, the flat-boat belonging to this stream was laid up at Greenwood, Miss., a place on Yazoo River, a few miles below the mouth of Tallahatchee, and upon the resumption of work this season it was found that it would be much more economical to build a new flat-boat than to have the old one towed to the mouth of Coldwater, and the old boat could be used to advantage in the immediate vicinity on Yallahusha River.

A new flat-boat was consequently built at Batesville, and active operations on removing obstructions commenced September 15. These were carried on, moving down-stream, until November 30, when the party was disbanded.

A great many more obstructions were found in the river this season than during the previous one, owing to the great number of trees caved into the river with the bank.

The amount of work done during the season was as follows:

Number of snags pulled	405
Number of overhanging trees cut	241
Number of trees deadened	737
Number of trees and logs cut from river bed	784
Number of yards of brush cut along banks	6, 740
Distance traveled in miles	74

No further appropriation having been made at the last session of Congress for the continuation of this work, no work will be done. With the appropriation asked for for the fiscal year ending June 30, 1885, it is proposed to continue the improvement as heretofore.

The estimated cost of the improvement of the whole river from Batesville to its mouth was \$40,000.

The former appropriations are as follows:

By act approved March 3, 1879	\$6, 000
By act approved June 14, 1880	9, 000
By act approved March 3, 1881	3, 000
By act passed August 2, 1882	3, 000
Amount expended to June 30, 1882	18, 000

COMMERCIAL STATISTICS.

About 15,000 bales of cotton, 40,000 sacks of cotton-seed, and 10,000 staves are annually brought out of this river, the principal portion being from below the mouth of Coldwater. Two steamboats, of an estimated tonnage of 700 tons each, and drawing 20 inches of water, navigate the lower river. For the navigation of the upper river, a boat called the Dixie, was built last fall. She has a tonnage of 75 tons, and draws 14 inches. She made ten or twelve trips during the season and handled 300 bales of cotton, 500 tons of cotton-seed, 50,000 feet of lumber, besides various other merchandise. It is estimated that from 1,200

to 1,500 bales of cotton, and a corresponding increase of merchandise, will be shipped during the coming season. If the improvement of the river is continued, it is probable that a great deal of cotton, which is now shipped by way of the railroads, will find its way out by means of boats.

Money statement.

Amount appropriated by act passed August 2, 1882.....	\$3,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	2,681 72
July 1, 1883, amount available.....	318 28
Amount (estimated) required for completion of existing project.....	19,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	10,000 00

R 8.

IMPROVEMENT OF COLDWATER RIVER, MISSISSIPPI.

I assumed charge of this work June 30, 1882, by virtue of Special Orders No. 125, paragraph 2, War Department, Adjutant-General's Office, Washington, D. C., May 31, 1882, relieving Maj. W. H. H. Benyard, Corps of Engineers, United States Army.

No work was done on this stream during the year. The river runs mostly through a thinly settled country, and the cost of any improvement would not be warranted by the amount of commerce.

No money was appropriated for this stream last year, and none was asked for.

The former appropriations are as follows :

By act approved March 3, 1879.....	\$7,000 00
By act approved June 14, 1880.....	4,000 00
Amount expended to June 30, 1882.....	9,660 99

No further appropriation is asked for this improvement.

COMMERCIAL STATISTICS.

There is but one boat navigating this stream, making occasional trips. It is estimated that 1,500 bales of cotton and 2,500 sacks of cotton-seed are annually shipped from this stream, and about 10,000 staves are floated out during the season.

Most of the commerce of this stream is shipped by way of Friar's Point, on the Mississippi River.

Money statement.

July 1, 1882, amount available.....	\$1,339 01
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	345 10
July 1, 1883, amount available.....	993 91

R 9.

IMPROVEMENT OF TCHULA LAKE, MISSISSIPPI.

I assumed charge of this work June 30, 1882, by virtue of Special Orders No. 125, paragraph 2, War Department, Adjutant-General's Office, Washington, D. C., May 31, 1882, relieving Maj. W. H. H. Benyaurd, Corps of Engineers, United States Army.

The work on this stream was inaugurated during the season of 1881, and consists principally in the removal of overhanging trees and a few snags.

The operations on the lake this season have consisted in the removal of obstructions as heretofore. A small flat was purchased, and work commenced at the lower end of the lake and was carried on up-stream, until the upper end was reached.

Several drift-piles were found to have formed from the timber cut last year and had to be broken up.

During the season the following work was accomplished:

Number of trees cut	13,562
Number of snags and logs cut	3,348
Number of trees girdled	6,120
Number of trees topped	103

The leaning timber has now nearly all been cut down, and to complete the improvement of the lake it is necessary to remove some snags, for which steam-power will be necessary. Several springs will have to be destroyed, which are bringing sand into the lake, and the sand-bars thus formed will have to be removed.

For the details of the season's operations, I would call attention to the report of Mr. W. S. Davis, transmitted herewith. No further appropriation having been made for this improvement, no work will be done during the coming season. With the appropriation asked for, for the fiscal year June 30, 1885, it is proposed to continue the improvement as heretofore.

The estimated cost of this improvement was \$10,000.

The former appropriations are as follows:

By act approved March 3, 1881	\$3,000 00
By act passed August 2, 1882	2,500 00
Amount expended during the fiscal year ending June 30, 1882	2,704 02

COMMERCIAL STATISTICS.

The country along the lake is highly productive. Two steamboats, belonging to the Yazoo River Line of packets, navigate this lake; their estimated tonnage is 500 tons each, and draught 20 inches.

Cotton	bales..	15,000
Cotton-seed	sacks..	20,000
Return freight (estimated)		\$300,000

Money statement.

Amount appropriated by act passed August 2, 1882	\$2,500 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	2,228 54
July 1, 1883, amount available	271 46
Amount (estimated) required for completion of existing project	4,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	4,500 00

REPORT OF MR. WALTER S. DAVIS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., December 26, 1882.

CAPTAIN: I have the honor to submit the following report of work done on Tchula Lake, Mississippi, during the past season:

In compliance with your instructions given August 25, I proceeded to Vicksburg, Miss., to procure the Tchula Lake property deposited there by Assistant Engineer H. C. Wilson, on ending his work on the lake in 1881, and went thence to Yazoo City, where I made up my party, and thence to Stonewall, Miss., 8½ miles above the mouth of the lake. I stopped at this place because my instructions directed me to work up the lake, and I found no work to be done below, it being from 100 to 200 feet wide and 10 feet above the low-water mark, on account of a rise caused by recent rains, so that the logs in the channel were out of sight. I camped three-fourths of a mile above Stonewall, Miss., and commenced work September 1. Before commencing to work I consulted Mr. Marsey Johnson, master of one of the Yazoo River packets, as to what points pilots found most difficulty in passing, and the following is an extract of the written statement that he furnished me:

"From Stonewall to Black Creek the lake is close (narrow, or obstructed by overhanging trees); then from Black Creek to Belmont it is good; from Belmont to Tchula, close in places; good from Tchula to Oswego, but from Oswego to Oregon, a distance of 4 or 5 miles, it is close; good from Oregon to Dr. Keirn's residence; from here around the bend to a church on his place, very close—clear well—also below Black Creek as mentioned above."

On learning that the flat-boat built by Mr. Wilson last year had disappeared at some time during the high water of 1882, I purchased a good flat-boat (that had been used as a ferry boat) 9 by 28 feet, and built a deck projecting 1½ feet over each gunwale. This gave me a floor 12 by 28 feet, on which I erected a small shed for a kitchen and pitched my tent, leaving a space between the kitchen and tent sufficient for holding the provisions. I attached oar-locks to the front of the barge and made large oars for pulling up the stream, there being a strong current from Black Creek to Stonewall. That part of Tchula Lake below Black Creek is usually called "Little River."

In consequence of the high water, I had to leave most of the logs and snags between Stonewall and Quafalona, because they were hidden under the water so that I could not reach them and had no machinery for grappling them. Besides these, I omitted cutting many leaning willows that were surrounded by water to such a depth that, had I cut them, their stumps would have remained as snags. It was my intention to return to this part of the lake after the water should have fallen, but did not find an opportunity.

From Quafalona to Black Creek, a distance of 12 miles, I found many overhanging trees and a quantity of logs, stumps, and snags in the channel. The logs were generally entire trees that had been cut on the lake shore last year and brought down by high water and left in drift heaps. A great many were imbedded in the banks and bottom of the lake, by a deposit of sand or mud formed by the high water of last winter. I cut to pieces as many of these as were lying on the banks, and cut off the branches of those in the water, whenever I could reach them. The high water mentioned above left a deposit on the banks of the lake, in its channel and over this part of the swamp, of from 1 to 24 inches. I learned from some of the early settlers that the lake has been filling up for years. In many places sliding banks had inclined the trees over the water all of these I cut. In this part of the lake I worked from September 10 to October 14, and cut down and cut into pieces 7,504 trees, girdled 2,874, cut or removed from the channel 2,731 snags, logs, and stumps, and topped or limbed eighteen trees that were too large to cut into the lake, giving a width of lake of 200 feet.

Tchula Lake receives its principal tributaries from the east or hill country; immediately below their mouths the lake is swift and shallow (during low water) on account of the *débris* they bring down from the hills, while above these mouths for several miles the lake is sluggish and deep, being dammed by the bars below.

Above Black Creek the lake is wide and deep to within 1 mile of Tchula City, whence it is shallow up to the mouth of Funnegusha Creek. I removed some obstructions from the lake below Holly Bank, but from here to Tchula City there was no work to be done, because it was so thoroughly cleared by assistant engineer H. C. Wilson last year.

The lake is wide and deep from Tchula to Oswego, but from Oswego to Oregon it is narrow and crooked. In this part of the lake I removed the trees from the inner sides of the bends, so as to relieve them as much as possible.

From Oregon to Linden I found very little work to be done, but from Linden around Kiern's Bend to Crescent the tops of leaning trees approached from opposite banks to within 60 feet, and in some places even less. I cut many large trees and stumps, mostly cypress, even with the surface of low water. Some of these were 6½ feet in diameter. I left this part of the lake twice as wide as it was when I entered it.

1152 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

From Crescent to the head of the island there were many obstructions that ought to have been removed, such as logs brought down by the high water and lodged in the channel, but, the appropriation having been exhausted, when I reached the former place I discharged my party as instructed.

Between Marcella Quarters and Watson's there is a large lump in the channel, caused by sliding bank, that could easily have been shoveled down, as it is only 8 feet high, 80 feet long, and 40 feet wide, but I had no shovels while there, and could not find time to return after leaving.

At Lynchfield there is a large sand-bar on the right bank, caused by a bold stream that comes from a large hole in the lake shore, 600 feet in circumference, and filled with big sand-springs. The width of the lake at low water above and below the bar is over 200 feet and its depth 6 to 8 feet, while opposite the bar the width is 56 feet and depth $1\frac{1}{2}$ feet. The length of bar is 350 feet and its height (in the middle of lake before the bar was formed) is $7\frac{1}{2}$ feet above low water. If the little stream that causes the bar were dammed where it comes from the hole the springs would be destroyed by the deposit high water would leave in the hole, and the sand-bar could be shoveled away. I learned from people at Lynchfield that both bar and hole are constantly increasing in size as the sand is washed from the hole to the bar, and that the springs were not there until a deep gully had washed in the slope towards the lake, but this wash is now filled above the hole and crossed by a road. Unless the springs are destroyed the growing bar will soon dam the lake, as there is not current enough in the lake to remove it.

The table below shows the amount of work done on Tchula Lake during each month of the last season:

Locality.	Month.	No of trees cut down.	No. of snags, logs, or stumps cut.	No. of trees girdled.	No. of trees topped.	Distance.
						Miles.
From mouth to Stonewall...	August					8 $\frac{1}{2}$
From Stonewall to Pleasant Ridge.	September..	5, 427	2, 550	2, 729		20
From Pleasant Ridge to Linden.	October	5, 533	428	1, 028	32	28
From Linden to head of island	November ..	2, 602	370	2, 370	71	10 $\frac{1}{2}$
Total	2 $\frac{1}{2}$ months...	13, 562	3, 348	6, 120	103	67

Besides the sand-bars I have mentioned, there are many logs in the channel of the lake that ought to be removed, so that boats could run at a stage of water lower than that at which they have had to quit the lake heretofore.

I think \$2,500 could be very judiciously expended for continuing the improvement of Tchula Lake during the coming season.

Very respectfully, your obedient servant,

WALTER S. DAVIS,
Assistant Engineer.

Capt. A. M. MILLER,
Corps of Engineers, U. S. A.

R 10.

IMPROVEMENT OF YALLABUSHA RIVER, MISSISSIPPI.

I assumed charge of this work June 30, 1882, by virtue of Special Orders No. 125, paragraph 2, War Department, Adjutant-General's Office, Washington, D. C., May 31, 1882, relieving Maj. W. H. H. Benyard, Corps of Engineers, United States Army.

The work of improving this stream was commenced in 1881, and consisted in removing snags, logs, and overhanging timber.

Work was commenced at the lower end and continued up stream to within 30 miles of Grenada, Miss., the head of navigation. The flat-boat belonging to Tallahatchee River, which could not be used on that stream, owing to the cost of towing it to the mouth of Coldwater, was utilized on the improvement of this river.

The amount of work done during the season was as follows:

Trees cut	1, 503
Logs cut	1, 044
Snags removed	61
Trees deadened	1, 348
Yards of brush removed	120
Miles of river covered	70

During the coming season no work will be done, no money being available. With the appropriation asked for, for the fiscal year ending June 30, 1885, it is proposed to continue the improvement as heretofore.

The estimated cost of this improvement was \$7,000.

The former appropriations are—

By act approved March 3, 1881	\$3, 500
By act passed August 2, 1882	3, 500
Amount expended to June 30, 1882	3, 500

COMMERCIAL STATISTICS.

It is estimated that from 12,000 to 15,000 bales of cotton are produced along this stream. Of this amount but 3,000 goes by boat to Vicksburg, the balance being taken to the railroad. If the improvement of this stream were continued the greater portion of the cotton would probably be shipped by boat, and at reduced rates of freight.

Money statement.

Amount appropriated by act passed August 2, 1882	\$3, 500 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	3, 400 24
July 1, 1883, amount available	99 76
Amount that can be profitably expended in fiscal year ending June 30, 1885	3, 500 00

R II.

IMPROVEMENT OF BIG HATCHEE RIVER, TENNESSEE.

I assumed charge of this work June 30, 1882, by virtue of Special Orders No. 125, paragraph 2, War Department, Adjutant-General's Office, Washington, D. C., May 31, 1882, relieving Maj. W. H. H. Benyard, Corps of Engineers, United States Army.

The operations on the river this season have consisted, as during previous seasons, in removing obstructions to the safe navigation of the stream.

A flat-boat was built for transporting the party, the work being done by hired labor.

Operations commenced at Bolivar, Tenn., August 28, where the flat-boat was built, and continued down stream to Reed's Ledge, 27½ miles from the mouth, where the party was disbanded November 4, 1882.

The river was found to be at a very low stage and was advantageous to the work. Caving banks were found almost the whole length of the stream, and a good many trees were found which had already been caved into the river, many of them extending all the way across. In several places the river was very full of trees which were blown down and into the river by a cyclone.

Rack heaps were also encountered at nearly every shoal place, caused by the timber cut during the previous season jamming. The rack heaps were broken up, and will prove no further obstruction.

Near Covington, Tenn., the river is crossed by the Chesapeake, Ohio and Southwestern Railroad, at which place a draw-span has been placed. Several piles were found driven in the channel of the river, but they were removed so as to give safe navigation.

The following is a summary of the work done during the season:

Number of snags removed	512
Number of logs removed	919
Number of trees cut down	679
Number of trees deadened	243
Distance traveled in miles	185½

During the coming season no work will be done, as no appropriation was made for the continuance of the work. With the appropriation asked for, for the fiscal year ending June 30, 1885, it is proposed to continue the improvement as heretofore.

The estimated cost of the improvement was \$30,000.

The former appropriations are as follows:

By act approved June 14, 1880	\$10,000 00
By act approved March 3, 1881	3,500 00
By act passed August 2, 1882	3,000 00
Amount expended to June 30, 1882	13,068 11

COMMERCIAL STATISTICS.

Cotton	bales..	11,000
Cotton-seed	sacks..	35,000
Lumber	feet..	2,000,000
Staves	number..	500,000

At present about 5,000 bales of cotton and 15,000 sacks of seed are brought to Memphis by the railroads. If the stream were fully improved, it is presumed the entire amount would find its way out by boat.

Money statement.

July 1, 1882, amount available	\$431 89
Amount appropriated by act passed August 2, 1882	3,000 00
	<hr/>
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	3,431 89
	<hr/>
July 1, 1883, amount available	261 26
	<hr/>
Amount (estimated) required for completion of existing project	13,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	10,000 00

R 12.

IMPROVEMENT OF SOUTH FORKED DEER RIVER, TENNESSEE.

No work has heretofore been done upon this improvement.

With the appropriation of August 2, 1882, it is proposed to improve the navigation by the removal of the obstructions from the bed and banks of the stream. For this purpose a party will be organized, with the necessary camping outfit, and will be sent to the river to commence operations as soon as the stage of water will permit.

With the appropriation asked for for the fiscal year ending June 30, 1885, it is proposed to continue the work of removing the obstructions.

The estimated cost of this improvement was \$19,250
Amount appropriated August 2, 1882 3,000

COMMERCIAL STATISTICS.

Cotton bales.. 15,000
Cotton-seed tons.. 6,000
And other products, the quantity of which was not given.

It is estimated that, should the improvement of this stream be continued, 5,000 additional bales of cotton and 2,000 tons of seed would find its way to market by this means.

The improvement of this stream would open up a large area of forest timber, only to be reached in this way.

Money statement.

Amount appropriated by act passed August 2, 1882 \$3,000 00
July 1, 1883, amount available 3,000 00
Amount (estimated) required for completion of existing project 16,250 00
Amount that can be profitably expended in fiscal year ending June 30, 1885. 10,000 00

R 13.

IMPROVEMENT OF THE OUACHITA RIVER, ARKANSAS AND LOUISIANA.

I assumed charge of this work June 30, 1882, by virtue of Special Orders No. 125, paragraph 2, War Department, Adjutant-General's Office, Washington, D. C., May 31, 1882, relieving Maj. W. H. H. Benyaurd, Corps of Engineers, United States Army.

After some necessary repairs had been made upon the snag-boat O. G. Wagner, she was sent to this river, and entered upon her usual work of removing wrecks, snags, and other obstructions to navigation. She arrived in the river and began work on August 29, and was withdrawn November 30, 1882. It was deemed advisable to go up the river as far as the stage of water would permit, and from there work down stream.

During the season the following amount of work was accomplished:

Logs and snags destroyed 780
Leaning trees cut down 596
Shore snags and stumps destroyed 300
Rack heaps removed 10

Wreck of steamboat Little Bob B. was also removed.

For the details of the work I would call attention to the report of Capt. E. F. White, submitted herewith.

During the coming season no work will be done, no money having been appropriated for the continuation of the work.

With the appropriation asked for for the fiscal year ending June 30, 1885, it is proposed to continue the snagging operations and the removal of wrecks, and to complete the dams at Catahoula Shoals, and to build wing-dams at several other shoals, which are drawbacks to navigation.

It is recommended that an appropriation of \$5,000 be obtained for Black River, which is naturally a part of Ouachita River, as all the boats running in Ouachita River and its tributaries must necessarily

navigate this stream. It is proposed to apply the money to snagging operations, for which the snag-boat Wagner can be used.

There are two saw-mills in the vicinity of Monroe, one 5 miles above and the other 2 miles below, which keep the river in a wretched condition by their rafts, which constantly block the river and obstruct navigation.

The former appropriations for this stream are as follows:

By act approved March 3, 1871	\$51,000
By act approved June 10, 1872	100,000
By act approved March 3, 1873	60,000
By act approved August 14, 1876	12,000
By act approved June 18, 1878	10,000
By act approved March 3, 1879	10,000
By act approved June 14, 1880	8,000
By act approved March 3, 1881	12,000
By act passed August 2, 1882	12,000

The first project adopted for the improvement of this stream was by means of a system of locks and dams at an estimated cost of \$1,163,083.75, which also included the cost of a non-propelling crane-boat. This project was abandoned, but not until after a portion of the funds appropriated were expended for material, surveys, &c. Out of the balance remaining an iron-hull snag-boat was built for operating in the river.

No detailed estimates can be given for the improvement of the Ouachita with the snag-boat, as the nature of the work must be continuous from year to year, owing to the character of the obstructions which each flood brings down. The cost of running a snag-boat eight months in the year, with incidental repairs, is \$20,000.

COMMERCIAL STATISTICS.

The amount of freight carried during the year was as follows:

Cotton, 130,440 bales	\$6,522,000
Cotton-seed, 12,000 tons	120,000
Hides, 300 bales	12,000
Cotton-seed oil, 150 barrels	1,800
Staves, 300,225	24,000
Cattle, 1,500 head	30,000
Hogs, 1,500	9,000
Ash wood, 30,000 cords	150,000
Rafts of ash and walnut timber	750,000
Produce and sundries	150,000
Value of up freights	2,000,000
	<hr/> 9,768,800

The number of boats engaged in navigating this river was a regular line of six steamers, besides eight independent ones.

The following table shows the changes in the rates of insurance since the improvement of the river from 1874 to 1883:

Locality.	Rate in 1874.	Rate in 1883.	Amount of reduction.
	Per cent.	Per cent.	Per cent.
Below Harrisonburg			
Above Harrisonburg and below Trenton			
Trenton to Alabama Landing	1		
Alabama Landing to Camden	14		
Camden to Arkadelphia	2	1	
Above Arkadelphia	24	24	

Money statement.

July 1, 1882, amount available	\$1,711 51
Amount appropriated by act passed August 2, 1882	12,000 00
	<hr/> 13,711 51
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	13,711 51
	<hr/> 20,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	

REPORT OF CAPTAIN E. F. WHITE.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., January 6, 1883.

CAPTAIN: I most respectfully submit the following report of the operations of the United States snag-boat O. G. Wagner, in the Ouachita River, from August 29 to November 30, 1882.

Upon receiving your instructions, I had the necessary repairs and outfit made to the Wagner, and proceeded with her to the Ouachita River, to remove obstructions to navigation and clean the banks of drift logs and overhanging trees. The season for such work on this river being well advanced, I concluded, upon consultation with my pilot, to go up the river as far as the stage of water would admit and work down stream as the water receded. Upon my arrival at Ouachita City, I found the river falling very fast, and deemed it advisable not to take the boat any higher, but to begin at this point and work down stream. I continued the work as far as Columbia, a distance of 90 miles, when the river began to rise and continued fluctuating; hence it was deemed best to adopt the plan of moving up or down the river and work above or below certain localities, according to the rise or fall of the water.

I received a communication October 1, from the steamboatmen engaged on the river, that the wreck of the steamboat Little Bob B., sunk at the entrance to chute at Catahoula Shoals, was a dangerous obstruction to navigation. I referred the communication to you, and October 6 received instructions to proceed and remove the wreck. Upon my arrival there I found that it would be advisable to only remove a portion, as part of the wreck was in such a position as would assist the Government work already commenced at the shoals. I removed what I thought was necessary, which gave a clear entrance to the chute in low water, thus enabling steamers to reach Columbia, a distance of 50 miles above the shoals.

On account of the rapid rise in the river, operations were suspended on the 27th of November, 1882, when I was ordered to proceed with the snag-boat to New Orleans and lay up the boat and discharge crew.

The operations of this boat during the season extended from the mouth of the river up to Ouachita City, a distance of about 160 miles, and resulted in the following summary of work accomplished:

Logs and snags destroyed	780
Leaving trees cut down	596
Shore snags and stumps destroyed	300
Rack heaps removed	10

And removed portion of the wreck of steamboat Little Bob B.

In connection with the improvement of the Ouachita River I would respectfully recommend that the wrecks, a list of which, with their location, has been furnished you, be advertised, so that in commencing next season's operations they can be removed as the boat comes up to them in her regular work, thereby saving a great deal of valuable time.

I respectfully recommend that the work at Catahoula Shoals be continued, and the lower end of the dam be raised 2 feet, and the upper side at the lower end protected by a double row of piling, to act as fenders in case boats passing through the chute should be carried by the current onto the lower side. The upper side should also be raised 2 feet above its present height, which would enable boats to use the chute on a higher stage of the river than at present.

The velocity of the water through the chute during last high water was about 5 miles per hour; depth of water in the channel, 4.5 feet; estimated cost to complete the improvement, \$2,000.

The following localities require special attention: Sandbar below Harrisonburg, Fenner's Bar, Taylor's Bar, and Monroe Bar. The latter is a very serious obstruction

to navigation, and in low water, when steamers are able to navigate the lower part of the river, they cannot cross this bar to get to the city, but are compelled to stop at Pargaud's Landing, a distance of 3 miles below.

I would respectfully recommend that wing-dams of stone and brush be constructed at Monroe Bar, at an estimated cost of \$3,000, and that a channel be dredged through the bars below Harrisonburg and through Fenner's and Taylor's bars. That part of the river between Monroe and Taylor's bars has not received the attention that it should have, and in extreme low water it is very dangerous to the small steamers running on the river. I would recommend that when the *Wagner* comes to that part of the river instructions be given to work her between the two bars, and should she complete the work and not be able to cross the bar, the boat could be laid up there and crew discharged until such time as the river would allow the steamer to commence the work again.

Heretofore it has been necessary to keep the *Wagner* from being caught above the bars when the water fell, as she was needed for work in other rivers; but now that these rivers are supplied with boats to improve them, it is not necessary or practicable to do work only partly in certain portions of the river for fear of being shut in above the bars, when by steady work these portions can be effectually and thoroughly improved.

Should the appropriation for the Ouachita River be available, I would respectfully recommend that the *Wagner* be sent to the upper part of the river by the 1st of April, as the stage of water will not allow the working of the boat in that portion after the spring months.

The principal work to be done will be the removal of snags and cutting leaning trees. In a number of places the overhanging trees are a great danger to life and property. The steamboatmen have requested me to call your attention to that part of the upper river known as "Thirteen Points," where the leaning trees are very dangerous.

I respectfully call your attention to the state of the river from Monroe to a point 2 miles above Gerspach's Saw-mill, a distance of about 5 miles above Monroe. The river is kept in a wretched condition by rafts, cypress and pine logs, usually known as sawyers. On my way up the river with the *Wagner* it was with great difficulty and risk that we passed through the rafts intended for the saw-mill; both banks and the river were covered, leaving just width enough for the boat to pass through. The condition the river is kept in by the rafts and drifting logs is something that should receive special attention, and the owners of the mill be compelled to keep their logs on the banks and not be allowed to obstruct navigation. Two miles below Monroe there is another saw mill, and during low water the channel runs close to the bank where the mill is situated, and at times it is with great difficulty and risk that boats can pass that point either going up or down the river.

I would respectfully recommend that an appropriation of \$5,000 be asked for to remove snags and other obstructions on Black River, as that stream is the thoroughfare for steamboats navigating Ouachita, Tensas, Boeuf, and Little rivers, Bayou Macon, Bayou Bartholomew, and Bayou d'Arbonne.

With the above amount it could be put in a good navigable condition for both high and low water.

Very respectfully, your obedient servant,

E. F. WHITE,

Commanding United States Snag-boat O. G. Wagner.

Capt. A. M. MILLER,
Corps of Engineers, U. S. A.

R 14.

IMPROVEMENT OF BAYOU BARTHOLOMEW, LOUISIANA AND ARKANSAS.

I assumed charge of this work June 30, 1882, by virtue of Special Orders No. 125, paragraph 2, War Department, Adjutant-General's Office, Washington, D. C., May 31, 1882, relieving Maj. W. H. H. Benyaurd, Corps of Engineers, United States Army.

This improvement was commenced in July, 1881, and operations were begun at Baxter Station, Ark., and were continued down stream as far as Bartholomew, Ark. This season work was commenced at Bartholomew, Ark., and continued on down stream as far as Lind Grove, La.

The flat-boat which was used last season had sunk during the high-water season, but it was raised and caulked and utilized during the past

season. The work on the boat was finished August 29, 1882, and active operations towards removing obstructions were then begun, and continued until December 1, when they were discontinued, owing to high water.

The following is a summary of the work done on the river during the season:

Number of trees cut down	2,229
Number of logs removed	1,961
Number of stumps removed	151

Besides this, a large amount of brush and one rack heap were removed. The report of Mr. R. M. Spicer, transmitted herewith, will give the details of the work.

During the coming season no work will be done, no further appropriation having been made for this stream. With the appropriation asked for for the fiscal year ending June 30, 1885, it is proposed to continue the improvements as heretofore.

Estimated cost of this improvement was \$26,862.

The former appropriations are:

By act approved March 3, 1881	\$8,000 00
By act passed August 2, 1882	5,000 00
Amount expended to June 30, 1882	7,417 74

COMMERCIAL STATISTICS.

Cotton carried out on steamboats	bales.. 48,000
Cotton carried out by rail	do. 12,000
Oak staves carried out on flat-boats	250,000
Oak staves carried out on steamboats	30,000
Value of return freights	\$1,000,000

The rates of insurance on freight for all points below and up to Point Pleasant have been reduced one-eighth per cent. on account of the improvements in this stream.

Money statement.

July 1, 1882, amount available	\$582 26
Amount appropriated by act passed August 2, 1882	5,000 00
	<hr/> 5,582 26
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	3,976 81
	<hr/> 1,605 45
July 1, 1883, amount available	1,605 45
Amount (estimated) required for completion of existing project	13,862 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	14,000 00

REPORT OF MR. R. M. SPICER, OVERSEER.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., December 11, 1882.

SIR: Inclosed you will please find report of work done on Bayou Bartholomew, Arkansas and Louisiana, during the season of 1882.

I received instructions from you to continue work on Bayou Bartholomew on August 21. I employed foreman, cook, and three laborers, and left Memphis on the steamer City of Vicksburg, and arrived at Baxter, Ark., on the 23d of August, where all the property was stored from last season. After looking property over, I found everything as I had left it. I purchased supplies, and, employing five teams, I left on the 25th of August for Bartholomew, where I left off work last season, and where I left the flat-boat in charge of Dr. A. Owens. On my arrival at Bartholomew I found the

boat had sunk, and I reported the same to you. I got everything ready, and pulled her out on shore, and found that she was in a very leaky condition, but got all the leaks stopped, and let her in the water on the 29th of August. I had no trouble with the boat during the season, only she had to be pumped out every night. After getting all the property on the boat, I commenced work where I had left off last season.

I cut during the season, from September 1 to December 1, 2,229 trees, 1,961 logs, and removed 151 stumps. I found a great deal of heavy underbrush that had to be cut on the points that was greatly in the way. I also destroyed a very large rack-heap just below Lind Grove that has been a great deal of trouble to the steamboats.

The steamer Lind Grove passed up the bayou on the 27th of November. She went up the bayou as far as Poplar Bluff. On her return she had on board 800 bales of cotton. On her return up the bayou, the second trip, I went on board and had a talk with the captain. He was very much pleased with the work that had been done, and had no trouble in navigating the bayou where I had worked over, and he seemed to be very sorry that I could not get any further down the bayou, but said that the water was too high at present to do much good; he would like very much to see the work continue next season.

I received instructions from you on the 1st of December to discontinue work on the bayou, and make arrangements to store all the property at Lind Grove, and leave the boat with somebody. I made arrangements with Mr. R. M. Hardy to take care of boat and property for \$15 a month.

I left Lind Grove December 4, and arrived at Memphis December 7, and reported at your office according to instructions.

I remain, very respectfully, your obedient servant,

R. M. SPICER.

Capt. A. M. MILLER,
Corps of Engineers, U. S. A.

R 15.

IMPROVEMENT OF TENSAS RIVER, LOUISIANA.

I assumed charge of this work June 30, 1882, by virtue of Special Orders No. 125, paragraph 2, War Department, Adjutant-General's Office, Washington, D. C., May 31, 1882, relieving Maj. W. H. H. Benyaurd, Corps of Engineers, United States Army.

The improvement of this stream was commenced in September, 1881, and continued during that season, and consisted in removing obstructions from the bed and banks of the stream.

No further appropriation having been made for this work, it was discontinued.

The estimated cost of this improvement was \$23,000.

The former appropriation was:

By act approved March 3, 1881, \$3,000.

With the amount asked for for the fiscal year ending June 30, 1885, it is proposed to continue the improvement as heretofore.

COMMERCIAL STATISTICS.

8,000 bales of cotton, valued at	\$400, 000
3,000 tons of cotton seed	30, 000
Miscellaneous products, &c.....	10, 000
Value of up freights, &c	200, 000
Total	640, 000

Money statement.

Amount (estimated) required for completion of existing project	\$20, 000 00
Amount that can be profitably expended in fiscal year ending June 30 1885.	10, 000 00

R 16.

IMPROVEMENT OF BOEUF RIVER, LOUISIANA.

I assumed charge of this work June 30, 1882, by virtue of Special Orders No. 125, paragraph 2, War Department, Adjutant-General's Office, Washington, D. C., May 31, 1882, relieving Maj. W. H. H. Benyaurd, Corps of Engineers, United States Army.

The improvement of this stream, which consists in the removal of snags, leaning timber, and other obstructions to navigation, was continued during the past season. A flat-boat was built at Rayville, La., and equipped with the necessary outfit. Work was commenced September 9, and was carried on down-stream until December 20, when the party was withdrawn from the stream.

During the season the following work was accomplished :

Number of trees cut	1,580
Number of trees deadened	2,458
Number of snags cut	363
Number of stumps removed	310
Number of logs removed	410
Number of rack-heaps destroyed	3

During the coming season no work will be done, no appropriation having been made for carrying on the same. With the appropriation asked for for the fiscal year ending June 30, 1885, it is proposed to continue the improvement as heretofore.

The estimated cost of this improvement was \$20,000.

The former appropriations are:

By act approved March 3, 1881	\$5,000
By act passed August 2, 1882	5,000
Amount expended to June 30, 1882	5,000

COMMERCIAL STATISTICS.

4,500 bales of cotton, valued at	\$225,000
2,000 tons of cotton-seed	20,000
Miscellaneous products, &c	20,000
Value of return freights, &c	100,000
Total	365,000

Since the improvement of this stream has been commenced, the rates of insurance on freight, below and up to Point Jefferson, have been reduced from $1\frac{1}{4}$ to seven-eighths per cent., a difference of one-fourth per cent.

Money statement.

Amount appropriated by act passed August 2, 1882	\$5,000 00
July 1, 1883, amount expended during fiscal year	4,743 99
July 1, 1883, amount available	256 01
Amount (estimated) required for completion of existing project	10,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	10,000 00

R 17.

IMPROVEMENT OF CYPRESS BAYOU, TEXAS AND LOUISIANA.

I assumed charge of this work June 30, 1882, by virtue of Special Orders No. 125, paragraph 2, War Department, Adjutant-General's Office, Washington, D. C., May 31, 1882, relieving Maj. W. H. H. Benyaurd, Corps of Engineers, United States Army.

This improvement was commenced in 1872, and the project, which contemplated the cutting out and dredging a channel through the lakes and bayou, was completed in 1880. This gave good high-water navigation from Red River, in Louisiana, to Jefferson, Tex.

As has been stated in previous reports, should further improvements be desired it would require extensive works, the project recommended being to construct a dam across the lakes at Albany Point, and make a cut through to Red River, the estimated cost of which was \$372,580. This would give navigable water to Jefferson nearly all the year round, and, besides, would greatly benefit the navigation of Red River in the vicinity of Shreveport. If the work should be once begun, the estimated cost of the improvement should be made available in one appropriation for the successful execution of this work.

No appropriation has been made therefor.

No actual work in the way of improvement was carried on. The property was placed in charge of watchmen, and the dredge-boat belonging to this work was used at mouth of Red River.

The former appropriations are as follows :

By act approved June 10, 1872	\$10,000
By act approved March 3, 1873	50,000
By act approved August 14, 1876	13,000
By act approved June 18, 1878	15,000
By act approved March 3, 1879	6,000

Amount expended to June 30, 1882, \$91,415.42.

COMMERCIAL STATISTICS.

Jefferson is the principal distributing city for Cypress Bayou, and is situated at the head of navigation.

It is estimated that 100,000 bales of cotton will be received and handled there this season, which shows a considerable increase since 1880, when the receipts were 60,000 bales. One-half of the cotton received is forwarded by water to New Orleans.

A new cotton-seed oil mill has recently been built, and has received 610 tons of seed by water and 3,620 tons by rail. Seven hundred tons of cake and meal and 1,500 barrels of oil were shipped.

A new steamboat company is being formed to charter and build steamboats to run between Jefferson and New Orleans.

Money statement.

July 1, 1882, amount available	\$2,584 58
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	845 78
July 1, 1883, amount available	1,738 80

R 18.

WATER GAUGES ON THE MISSISSIPPI RIVER AND ITS PRINCIPAL TRIBUTARIES.

I assumed charge of this work June 30, 1882, by virtue of Special Orders No. 125, paragraph 2, War Department, Adjutant-General's Office, Washington, D. C., May 31, 1882, relieving Maj. W. H. H. Benyaurd, Corps of Engineers, United States Army.

Observations were continued at all the gauges during the year.

Repairs were made to those at Nashville, Tenn., Alexandria, La., and Carrollton, La.

The following gauges were tested and inspected: Jacksonport, Ark., Little Rock, Ark., Alexandria, La., Carrollton, La., Baton Rouge, La., and Red River Landing, La. It was the intention to have all the gauges tested and inspected, but owing to the fact that no provision was made for the gauges for the coming fiscal year the idea was abandoned.

The bulletin boards, recording each morning the stage of water, for the benefit of passing boats, were also continued. Records of the daily readings of the gauges were furnished the Mississippi River Commission.

Hydrographs of all the gauges were made, but retained in the office.

The following table gives a comparison of the flood of this year, with the highest water previously recorded at the different stations. As will be seen, the flood exceeded the highest previously known at several stations:

Stations.	Highest water previously recorded.		Highest water of 1883 to June 30.		Excess over previous highest records.
	Year.	Gauge reading.	Date.	Gauge reading.	
		<i>Fect.</i>		<i>Fect.</i>	<i>Fect.</i>
Cairo	1882	51.87	Feb. 27	52.17	0.30
Memphis	1882	35.15	Mar. 6	34.77	-0.38
Helena	1882	47.20	Mar. 8	46.90	-0.30
Mouth of White River	1882	48.40	Mar. 9	48.00	-0.40
Lake Providence	1862	40.87	Mar. 11	38.47	-4.40
Vicksburg	1862	51.10	Apr. 7	43.80	-7.30
Natches	1862	50.30	Apr. 7	44.00	-6.30
Red River Landing	1882	48.50	Apr. 9	45.20	-3.30
Baton Rouge	1874	36.15	Apr. 9	35.08	-1.07
Carrollton	1862	15.90	Apr. 7	15.40	-0.50
Saint Louis	1844	41.39	June 26	34.80	-6.59
Louisville (upper)	1832	40.76	Feb. 16	43.80	3.04
Louisville (lower)	1832	67.50	Feb. 16	70.10	2.60
Fort Leavenworth	1867	22.06	June 27	21.80	-0.26
Nashville	1882	55.30	Feb. 14	41.60	-13.70
Florence	1867	31.08	Jan. 28	20.30	-10.78
Jacksonport	1867	32.83	Feb. 19	32.00	-0.83
Little Rock	1857	31.00	Feb. 19	25.90	-5.20
Alexandria	1866	36.46	Mar. 27	25.45	-11.01

* The minus sign denotes that water was below previous highest record.

Copies of the gauge records at all the stations for the year are transmitted herewith.

During the coming fiscal year the gauge readings will be continued until the appropriation is exhausted.

In accordance with the joint resolution approved February 21, 1871, the sum of \$5,000 was to be appropriated annually for the gauges.

Money statement.

July 1, 1882, amount available	\$759 29
Amount appropriated by act passed August 2, 1882	5,000 00
	5,759 29
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	3,897 35
July 1, 1883, amount available	1,861 94
Amount that can be profitably expended in fiscal year ending June 30, 1885	5,000 00

APPENDIX S.

REMOVING SNAGS, ETC., FROM THE ARKANSAS RIVER—IMPROVEMENT OF ARKANSAS RIVER BETWEEN FORT SMITH AND WICHITA AND AT PINE BLUFF; AND OF RIVERS SAINT FRANCIS, WHITE, L'ANGUILLE, FOURCHE LE FÈVE, SALINE, BLACK, AND CURRENT, IN ARKANSAS AND MISSOURI.

REPORT OF CAPTAIN THOMAS H. HANDBURY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|--|--|
| 1. Removing snags, &c., from Arkansas River, Arkansas. | 6. White River above Buffalo Shoals, Arkansas. |
| 2. White and Saint Francis rivers, Arkansas. | 7. L'Anguille River, Arkansas. |
| 3. Arkansas River at Pine Bluff, Arkansas. | 8. Fourche Le Fève River, Arkansas. |
| 4. Arkansas River between Fort Smith, Arkansas, and Wichita, Kansas. | 9. Black River, Arkansas. |
| 5. White River between Jacksonport and Buffalo Shoals, Arkansas. | 10. Black River, Arkansas and Missouri. |
| | 11. Saline River, Arkansas. |
| | 12. Current River, Missouri and Arkansas. |

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., July 11, 1883.

GENERAL: I have the honor to transmit herewith my annual reports upon the works of river and harbor improvements under my charge for the fiscal year ending June 30, 1883.

Very respectfully, your obedient servant,

THOS. H. HANDBURY,
Captain, Corps of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

S I.

REMOVING SNAGS, WRECKS, ETC., FROM THE ARKANSAS RIVER, ARKANSAS.

This work was carried on during the year by the snag-boats C. B. Reese and Wichita, between Fort Smith, Ark., and the mouth of the river.

The *Reese* commenced operations about the middle of July and continued until the end of August. At this date she was withdrawn for two months, September and October, for work upon the White River. On the 1st of November she returned again to the Arkansas River, and

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worked until the end of January, 1883, making in all four and a half months for the season's work in this river.

Five hundred and eighty-four snags, weighing in the aggregate about 5,860 tons, and five drift piles, were removed. Seven hundred and eighty-six trees, growing along caving banks, were cut down to prevent their falling into the river and forming obstructions to navigation.

The *Wichita* commenced operations in this reach of the river October 1, and continued until the end of December. Seven hundred and three snags, weighing about 2,200 tons, and eight drift piles were removed.

The two boats during the season removed one thousand two hundred and eighty-seven snags and twelve drift piles.

The commerce of the river, during this season, so far as I have been able to ascertain from data furnished me by steamboatmen, is represented by about 70,000 bales of cotton and 75,000 tons of other freight, merchandise, cotton-seed, &c.

In my report of last year, published in the Chief of Engineers' Report, page 1571, an estimate of \$21,000 was made for continuing the survey of the Arkansas River from Little Rock, Ark., to its mouth. This report is respectfully referred to and the estimate again renewed.

ESTIMATE FOR THE FISCAL YEAR ENDING JUNE 30, 1885.

Working expenses of snag-boats, including current repairs, 12 months, at \$3,000 per month	\$36,000
For continuing survey of Arkansas River, from Little Rock, Ark., to its month	21,000
Total	57,000

Money statement.

July 1, 1882, amount available	\$4,356 41
Amount appropriated by act passed August 2, 1882	35,000 00
	<hr/>
	39,356 41
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	21,213 28
	<hr/>
July 1, 1883, amount available	18,143 13
	<hr/>
Amount that can be profitably expended in fiscal year ending June 30, 1885.	57,000 00

S 2.

IMPROVEMENT OF WHITE AND SAINT FRANCIS RIVERS, ARKANSAS.

Operations under the appropriation for these two rivers were confined to the removal of snags, overhanging trees, and other obstructions to navigation.

On the 1st of September the snag-boat C. B. Reese was withdrawn from the Arkansas River, and during this month and October worked upon the White between its mouth and Jacksonport, Ark. The snag-boat J. R. Meigs, which was designed for work upon this and other western rivers, was on the 15th of September transferred to Maj. A. M. Miller, for work upon the rivers in his charge.

During the two months in which the *Reese* worked in the White River, three hundred and two snags, aggregating about 2,300 tons

weight, and six drift piles were removed; one thousand three hundred and eighteen trees were cut down to prevent their falling into the river and forming obstructions to navigation.

Work on the Saint Francis River was commenced on the 20th of September and carried on until the end of December.

The manner of carrying on operations here was the same as during last season. A suitable outfit was chartered and a crew hired. The reach of river worked over extended from Wittsburg down through the cut-off to the mouth of "Old River," a distance of 65 miles. In this reach five hundred and sixty-two snags and three drift piles were removed, and eight hundred and sixty-six trees deadened.

These two rivers being entirely dissimilar in character, a plant that would be suitable for economical work in one would not be adapted to the other. It is suggested that a separate appropriation be hereafter made for each.

With the snag-boat now provided the necessary snagging work upon the White River as high up as Jacksonport could be economically done. This outfit is too large for the work upon the Saint Francis. Experience has shown that a strongly-built decked scow, drawing from 10 to 12 inches of water, supplied with suitable appliances for removing obstructions, and with accommodations for the working party, is the most economical and useful outfit that could be provided. Such an outfit would cost about \$4,000. Its running expenses would be about \$1,500 per month, and it could be worked to advantage for about 8 months in the year.

I am informed that during this season 20,000 bales of cotton, 30,000 sacks of seed, 1,000,000 feet of walnut lumber, 1,000 sacks of corn, besides stock, shingles, &c., were brought out of the Saint Francis River. The value of the miscellaneous produce, dry goods, &c., that have been taken into that country is estimated at about \$200,000.

ESTIMATE FOR THE FISCAL YEAR ENDING JUNE 30, 1885.

White River below Jacksonport, Ark.:

Working expenses of snag-boats, including incidental repairs, 6 months, at \$3,000 per month.....	\$18,000
Expenses in ordinary and general repairs.....	2,000
	<hr/> 20,000

Saint Francis River, Arkansas:

Outfit.....	\$4,000
Working expenses of same, 8 months, at \$1,500 per month.....	12,000
	<hr/> 16,000
	<hr/> 36,000

Total amount of appropriations.....	154,000
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Money statement.

July 1, 1882, amount available.....	\$505 64
Amount appropriated by act passed August 2, 1882.....	12,000 00
	<hr/> 12,505 64
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	9,363 68
	<hr/> 3 141 96
July 1, 1883, amount available.....	3 141 96
Amount that can be profitably expended in fiscal year ending June 30, 1885.	<hr/> 36,000 00

S 3.

IMPROVEMENT OF ARKANSAS RIVER AT PINE BLUFF, ARKANSAS.

In my report of last year concerning the progress of this work, I reported that an unexpected rise in the river, coming when the graded portion of the bank and revetment were in an incomplete condition, caused considerable damage to the work that was being carried on in Yell's Bend, about 2 miles above Pine Bluff. This is the upper side of a narrow neck where a cut-off is threatened which will do great injury to the navigation of the river and leave Pine Bluff several miles from a steamboat landing.

It was necessary at that time to suspend operations for want of the necessary funds. This was exceedingly unfortunate, as the situation and the character of the work were such that if a break was not at once repaired the whole of the season's work was liable to be damaged.

As soon after the new appropriation was made available as the necessary repairs to the plant could be completed, the repairs to the dike were made, and those in the revetment commenced. It was found necessary to regrade 3,000 feet of this bank. Two thousand four hundred feet of this was protected by a low-water protection extending 80 feet from the bank. One thousand feet of high-water protection was put in place. This connects with the low-water protection and extends 60 feet up the graded bank. This protection is made of brush, interwoven into the meshes of a wire net, the same essentially as has heretofore been used upon this work. Before the remaining portion of the graded bank could be protected in this manner, it became necessary by reason of the low state of funds available, and the failure of Congress to make appropriation for continuing the work, to suspend operations. This was again unfortunate, for the work is left in an incomplete state, exposed to the destructive action of the high waters of the river. In this, as in all other cases of river improvement where the means employed to accomplish a desired result are of necessity frail and of slight durability, the only true economy in carrying on the work is to have all the funds necessary at command and push it to a speedy conclusion.

Total amount of appropriations..... \$68,060

Money statement.

July 1, 1882, amount available.....	\$1,809 01
Amount appropriated by act passed August 2, 1882.....	20,000 00
	<hr/> 21,809 01
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	19,755 18
July 1, 1883, amount available	<hr/> 2,053 83
Amount that can be profitably expended in fiscal year ending June 30, 1885.	<hr/> 32,000 00

S 4.

IMPROVEMENT OF ARKANSAS RIVER BETWEEN FORT SMITH, ARKANSAS, AND WICHITA, KANSAS.

The work during the season on this portion of the Arkansas River was confined to the snagging operations of the snag-boat Wichita. Her

operations commenced on the 1st of July and were carried on until the end of September over that reach of the river lying between Fort Smith, Ark., and the mouth of the Grand River, Indian Territory.

During this time seven hundred and nine snags, weighing in the aggregate 1,350 tons, and twenty drift piles were removed, three hundred and thirty-eight trees were cut down, and two hundred and six deadened, to prevent them falling into the river and forming obstructions to navigation. The work done was a very great benefit to the commerce of this portion of the river. On the 1st of October, the *Wichita* left this locality and worked during the remainder of the season between Fort Smith and the mouth of the river.

It is proposed during the coming season to continue the snagging operations, and also to remove some gravel shoals and ledges of rocks that are troublesome to navigation during the low-water season.

I have been unable to get any recent reliable data as to the amount of river commerce in the Indian Territory other than that during this season the amount has increased very much over that of last.

Total amount of appropriations..... \$79,000

Money statement.

July 1, 1882, amount available	\$8,622 84
Amount appropriated by act passed August 2, 1882	20,000 00
	<hr/> 28,622 84
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	7,051 83
July 1, 1883, amount available	<hr/> 21,571 01
Amount that can be profitably expended in fiscal year ending June 30, 1885.	<hr/> 30,000 00

S 5.

IMPROVEMENT OF WHITE RIVER BETWEEN JACKSONPORT AND BUFFALO SHOALS, ARKANSAS.

A small party was at work upon this reach of the White River from about the middle of August to the middle of November. During this time one hundred and two snags and one thousand five hundred and forty-one overhanging trees were removed. A brush and gravel dam 294 feet long was put in the bed of the river near Bell's Point for the purpose of improving a very bad shoal that had formed at that point. The work resulted in great relief to navigation.

The amount done was not as satisfactory as desired, owing to the fact that the season was well advanced before commencing, and local rains kept the river at an unfavorable stage for doing such work as the project calls for. It is proposed to spend the funds now available during the coming season in improving shoals and removing snags and other obstructions to navigation.

Improvements of this character can, of course, give but temporary relief, and must, from time to time, be renewed. With the increased development of the natural resources of the country, the call for a more permanent improvement of this river becomes more urgent, and it becomes necessary to take steps having this object in view. As yet there is no instrumental survey of this river of sufficient accuracy to be used

as a basis for plans for such improvements as are necessary. The most that has been done in this direction is the result of hasty reconnaissances and one or two surveys of isolated localities made for special purposes.

In view of the necessity which must soon arise for a more permanent improvement of this river, it is suggested that steps be at once taken to collect the necessary data for an intelligent and comprehensive solution of the problem. The first and most important requisite is an accurate map, made from a careful instrumental survey, which will show all the features of the river and the country on its borders. The improvement should comprehend all that portion of the river between its mouth and the head of navigation, or the point that can be made the head within reasonable limits of expense. This distance is estimated to be about 600 miles. The cost of a survey such as is desired would be about \$80 per mile, or say \$50,000 for the whole distance. Of this, \$25,000 could be profitably expended in one season.

The commerce of this portion of the river during this season is represented approximately by 20,000 bales of cotton, 1,000 tons of cottonseed, 5,000 tons of general merchandise, besides large quantities of corn, ores of different kind, and various other commodities.

ESTIMATE FOR THE FISCAL YEAR ENDING JUNE 30, 1885.

Continuing work according to the present plan of improvement, improving shoals, removing snags, &c.....	\$20,000
Survey of White River from Forsyth, Mo., to its mouth.....	25,000

Money statement.

July 1, 1882, amount available	\$2,265 68
Amount appropriated by act passed August 2, 1882.....	6,000 00
	<hr/>
	8,265 68
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	2,146 80
	<hr/>
July 1, 1883, amount available.....	6,118 88
	<hr/>
Amount that can be profitably expended in fiscal year ending June 30, 1885.	45,000 00

S 6.

IMPROVEMENT OF WHITE RIVER ABOVE BUFFALO SHOALS, ARKANSAS.

Owing to the late date at which the appropriation of 1882 for this work became available, and to the unfavorable stage of water thus far during the year, it was thought best not to renew operations on this work. It was hoped that by additional appropriation the amount of funds available would be so increased that the work could be commenced upon a more extensive scale, and pushed forward to better advantage. No work has been done since the date of my last report, excepting such as was necessary for the care of the property pertaining to this improvement.

With the funds now available, it is proposed to remove some obstructions yet remaining at Buffalo Shoals, so as to get the same depth of water there as above, to repair the wing-dams, which have been more or less damaged by high water since their construction, and to continue the work of improvement up the river, in accordance with the project approved as far as the funds will suffice.

The work done has given satisfaction to the river men, and has materially increased the amount of their business in this locality. What the amount of this business is I have been unable to ascertain.

There is in this region a large tract of fertile country, to which no railroad has yet penetrated. It is very much in need of an outlet, and every improvement of the navigation of the river results greatly to their benefit.

Total amount of appropriations..... \$24,000

Money statement.

July 1, 1882, amount available	\$1,652 84
Amount appropriated by act passed August 2, 1882.....	4,000 00
	<hr/>
	5,652 84
July 1, 1883, amount expended during fiscal year exclusive of outstanding liabilities July 1, 1882	120 00
	<hr/>
July 1, 1883, amount available	5,532 84
	<hr/>
Amount (estimated) required for completion of existing project.....	32,600 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	12,000 00

S 7.

IMPROVEMENT OF L'ANGUILLE RIVER, ARKANSAS.

No work was done upon this stream during the year.

It is proposed to expend the funds yet available for this improvement in removing snags, overhanging trees, and other obstructions to navigation as occasion may require.

Total amount of appropriations..... \$17,000

Money statement.

July 1, 1882, amount available.....	\$3,149 47
July 1, 1883, amount available.....	3,149 47

S 8.

IMPROVEMENT OF FOURCHE LE FÈVE RIVER, ARKANSAS.

Early in September the work of removing snags, logs, and overhanging trees that impede navigation in this stream was resumed. A small steamer was chartered and supplied with the necessary outfit. A crew was hired and work commenced at the mouth of the river. It was carried on up-stream as far as Harrison Shoals, a distance of 60 miles.

This reach of the river is the same that was worked over last season.

The navigable portion of this stream lies between its mouth and Perryville, 40 miles above. Occasionally on extreme high water a boat goes to Harrison Shoals. Any improvement above this point would only be for the benefit of flat-boat navigation or to facilitate the rafting of logs and railroad ties. That portion of the river that has been improved is

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now reported to be in very good condition. Whenever there is sufficient water the boats have no difficulty in navigating it. The improvement has been of great benefit to the settlers in the valley of the stream.

From September 1 until the operations of the season closed early in December, ninety snags were removed, fourteen thousand four hundred and twelve overhanging trees cut down, and twelve thousand trees deadened along the banks.

During the last season about 2,000 bales of cotton, 100 tons of cottonseed, and 500 tons of general merchandise and produce were transported upon this river.

Should it be deemed advisable to continue the improvement of this stream above Harrison Shoals, \$10,000 could be expended thereon during the coming fiscal year.

Total amount appropriated	\$21,000
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Money statement.

July 1, 1882, amount available	\$101 85
Amount appropriated by act passed August 2, 1882	4,000 00
	<hr/>
	4,101 58
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	4,101 85

S 9.

IMPROVEMENT OF BLACK RIVER, ARKANSAS.

At the beginning of the fiscal year there was a small balance of \$810.66 of this appropriation available. This being too small an amount with which to commence any independent operations, it was thought best to hold it until the party working above the Arkansas line on this river under the appropriation for Black River, Arkansas and Missouri, should work down within the limits and then devote it to defraying the expenses of this party. The party has not reached the limit yet. The balance remains substantially as it was. The estimate for further work upon this part of the river is included in that submitted under the head of "Black River, Arkansas and Missouri."

Money statement.

July 1, 1882, amount available	\$810 66
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	17 50
	<hr/>
July 1, 1883, amount available	793 16

S 10.

IMPROVEMENT OF BLACK RIVER, ARKANSAS AND MISSOURI.

This work has for its object the removal of shoals, overhanging trees, snags, &c., which obstruct navigation in this river both in the States of Arkansas and Missouri. It was commenced at Poplar Bluff, Missouri, and has now been carried on during two seasons. It is performed by hired labor, using appliances that have been purchased from the appropriation.

At the end of last season the work had progressed from the place of beginning down-stream, a distance of 20 miles. The work of this season was commenced September 21, at Poplar Bluff, Mo., and some additional work done on that portion of the river gone over last season. It was continued down for a distance of 31 miles, 11 miles below where it terminated last season. At the end of December the cold weather and high water made it necessary to suspend operations.

During the season one thousand one hundred and seventy-five snags and five thousand three hundred and eighty-six trees of various sizes were removed. Over this distance of 31 miles, which before this work was commenced was but a mass of snags and overhanging trees, there is now a clear river that can be navigated at all times, day or night.

The river below this point is not so much obstructed, and it is hoped that in future operations a greater number of miles per season will be cleared.

The Black River from its mouth up to the mouth of Current River is in a fair navigable state. From Poplar Bluff to Current River the distance is estimated to be about 146 miles. There is yet 115 miles of this from which obstructions are to be removed in order that it may be said that this river is in a like condition.

The character of the banks and the country through which this river flows is such that for many years after these obstructions are removed, others of a like character will take their places. In order to keep the river free for navigation it will be necessary from time to time to remove these.

It is suggested that the most satisfactory outfit for this purpose will be a light-draught boat supplied with propelling power and the necessary appliances for removing snags and dredging or scraping the shoals where necessary. Such a boat would find constant employment in the Black River, and the White above the mouth of the Black.

With the funds now available it is proposed to continue the work on the present plan as far as they will suffice.

The following is the estimate of the amount of funds that could be profitably expended upon the Black River in Arkansas and Missouri during the coming fiscal year:

One light-draught boat and outfit.....	\$15,000
Expenses of operating same 7 months, at \$2,000 per month.....	14,000
Repairs and care in ordinary	1,000
	<hr/>
	30,000

I have been unable to obtain reliable data as to the amount of commerce on this river during last season. Large quantities of staves have been taken out of the country bordering on the upper portion and shipped by rail at Poplar Bluff. The amount of cotton and other produce that is taken from the lower portion of the river is constantly on the increase.

Total amount of appropriations for this river..... \$31,000

Money statement.

July 1, 1882, amount available.....	\$859 25
Amount appropriated by act passed August 2, 1882.....	10,000 00
	<hr/>
	10,859 25
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	5,980 65
	<hr/>
July 1, 1883, amount available	4,878 60
	<hr/>
Amount that can be profitably expended in fiscal year ending June 30, 1885.	30,000 00

S II.

IMPROVEMENT OF SALINE RIVER, ARKANSAS.

The active work of last season upon this stream was carried on between August 22 and December 9. It consisted in removing snags, logs, overhanging trees, and other obstructions of like character to the navigation of the stream. The work was done with the plant already provided and the necessary hired labor. It was commenced at Longview, the point at which the operations of the season before ceased, and was carried down to Godfrey's Landing, a distance of about 50 miles. Within this distance, three thousand seven hundred and seventy-two overhanging trees, five hundred and fifty-four snags and logs, one fish-trap and dam, one large pine raft, and four drift piles were removed; five hundred and fifty-six trees, also, were deadened.

The total distance that has been worked over on this stream, from Big Island, the place of beginning, to Godfrey's Landing, is now 230 miles, leaving 20 miles yet remaining to its junction with the Ouachita.

There are now two railroad bridges across this stream below Big Island; one at a point known as Hog's Shoals, about 4 miles below Cavaness Landing. This was erected by the Little Rock, Mississippi River and Texas Railway Company. It is an iron draw, 190 feet over all. The pivot pier is 26 feet in diameter, and the abutments occupy 5 feet each, leaving a space of but 77 feet in the clear for the passage of boats. The structure is about 4 feet above extreme high water, and makes an angle of about 10 degrees with the direction of the current. The other is at Varnell's Point, about 8 miles above Mount Elba. This was erected last summer by the Texas and Saint Louis Railway Company. It is a single, open, wooden bridge, which affords no means of passage for steamboats. It effectually blockades navigation above its location.

The principal products exported from the counties bordering on this stream are staves and cotton. It is estimated that about 200,000 staves will be shipped this season. About 10,000 bales is the average amount of cotton shipped by river each year.

It is proposed, as the necessary funds are made available, to continue operations on this stream as heretofore until the mouth is reached, and to then remove such shoals as, at the navigable stage of the water, interfere materially with navigation.

Total amounts of appropriations	\$16,500
Original estimate for improving this river	30,151

Money statement.

July 1, 1882, amount available	\$2,474 32
Amount appropriated by act passed August 2, 1882	4,000 00
	<hr/>
	6,474 32
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	4,128 25
	<hr/>
July 1, 1883, amount available	2,346 07
	<hr/>
Amount (estimated) required for completion of existing project	17,651 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	10,000 00

S 12.

IMPROVEMENT OF CURRENT RIVER, MISSOURI AND ARKANSAS.

With the small balance of \$534.83 which remained available for this work at the end of the last fiscal year, a boat and crew were hired for a few days during last September to work upon this stream. During the time they were so employed, eighty-five snags were removed between the mouth and Shoemaker's Landing.

Total amount of appropriations, \$7,000.

Congress having omitted this item from the river and harbor bill of 1882, it is assumed that a further prosecution of this work is not at present desired. No estimate is therefore submitted.

Money statement.

July 1, 1882, amount available	\$534 83
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	534 83

APPENDIX T.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN THE MOUTHS OF THE ILLINOIS AND OHIO RIVERS—IMPROVING HARBOR AND MISSISSIPPI RIVER AT ALTON—MISSISSIPPI RIVER OPPOSITE THE CITY OF SAINT LOUIS, AND AT OR NEAR CAPE GIRARDEAU AND MINTON POINT—IMPROVEMENT OF OSAGE RIVER IN KANSAS AND MISSOURI.

REPORT OF MAJOR O. H. ERNST, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|--|---|
| 1. Mississippi River, between the Illinois and Ohio rivers. | 4. Mississippi River at or near Cape Girardeau, Missouri, and Minton Point, Illinois. |
| 2. Harbor and Mississippi River at Alton. | 5. Osage River, Kansas and Missouri. |
| 3. Mississippi River opposite the city of Saint Louis, Missouri. | |
-

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., August 13, 1883.

GENERAL: I have the honor to transmit herewith the annual reports for the fiscal year ending June 30, 1883, upon the works under my charge.

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

T 1.

IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN THE ILLINOIS AND OHIO RIVERS.

Work has been carried on during the year at Arsenal Island, Horsetail, Twin Hollows, west bank, Twin Hollows, east bank, Pulltight, Beard's Island, "Jim Smith's," Chesley Island, Foster's Island, Piasa Island, and Alton Harbor.

Of these all except the last two form part of the general scheme for improving the navigation, making the improvement continuous, working down stream from Saint Louis. Their location is shown upon the Plate I which accompanied my last report.

The work at Alton was carried on in obedience to a special provision of the river and harbor act of August 2, 1882, and that at Piasa Island was rendered necessary by circumstances described further on.

ORGANIZATION.

First Lieut. F. V. Abbot, Corps of Engineers, was engaged upon special duties during the year until June 13, when he took charge of the work at Foster's Island.

The works at Piassa Island and Alton were under the immediate direction of Mr. C. D. Lamb, assistant engineer, who reported directly to me.

The organization for the other works was similar to that described in my last annual report; that is, there was at each work a resident engineer with one or more assistants, all being under the general supervision of a superintending engineer, through whom their reports to me were rendered.

There was an exception to this rule in the case of Foster's Island, after the assignment of Lieutenant Abbot to that work, his reports not passing through the superintending engineer. At the end of the year the other assignments were as follows, the prescribed duties of the different grades being the same as those described in my last report:

Superintending engineer: Mr. D. M. Currie.

Resident engineers: At Arsenal Island, Mr. C. D. Lamb; at Horsetail, Mr. E. D. Libby, assisted by Mr. S. B. Cady and Mr. C. P. Mitchell; at Twin Hollows, west bank, Mr. W. S. Mitchell, assisted by Mr. J. L. Duffy; at Twin Hollows, east bank, Pulltight, and "Jim Smith's," Mr. John O. Holman, assisted by Mr. A. F. Freis and Mr. B. E. Johnson; at Beard's Island, Mr. J. E. Savage; at Chesley Island, Mr. C. V. Merse-reau, assisted by Mr. J. W. Irwin.

At the supply depot Mr. S. S. Van Norman had charge of the subsistence department, and Mr. C. L. Stevenson of the engineering supplies and repairs.

On board the steamer General Gillmore Mr. J. L. Stubblefield acted as general receiver of materials and measured the brush and stone.

The reports of the assistant engineers and of the supply clerk and subsistence clerk are herewith transmitted, constituting Appendixes 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, and are intended to form part of this report.

ARSENAL ISLAND PROTECTION.

A history of this work to the beginning of the fiscal year was given in my last annual report. Its location is shown upon Plate I. Operations were resumed in August, 1882, and consisted in completing the low-water protection to the foot of the island, and placing the medium stage protection, consisting of a layer of riprap, as material could be procured. Two mattresses 40 feet wide—one 460 feet long and the other 560 feet long—were placed below low-water mark. Riprap was deposited upon the bank above low-water mark over a total length of 3,253 feet. Of this 330 linear feet was carried to a height 16 feet above standard low water; 880 feet to a height $11\frac{1}{2}$ feet above the same plane, and 2,043 feet to a height 8 feet. To complete the work it remains to extend the medium stage revetment over this length of 2,923 feet to the uniform height 16 feet above standard low water. For further details see Appendixes 1 and 2.

The total length of the protection is now 7,843 feet, of which 4,920 feet is completed, and the balance nearly so. The expenditures for the year were \$6,535.92.

HORSETAIL.

Operations at this locality during the year consisted in repairing the works constructed in previous years, which have been fully described

in former reports, and in constructing a new hurdle to connect Carroll's Island with the Illinois shore. (See Plate II.) The latter work was rendered necessary by a strong draught of water towards the chute east of Carroll's Island, hindering the bank building process at the down-stream portion of the Horsetail Reach, and causing an enlargement of the chute referred to. Whatever may have been the cause of this tendency, it was much increased by a remarkable series of violent winds which blew almost continuously from the west for three months during the spring. The hurdle is 2,450 feet long and, though not quite completed, has had the desired effect of causing heavy deposits in its vicinity.

The process of building up the new banks has continued in a satisfactory manner, the results obtained from the recent flood being very large upon the Missouri side, and upon the Illinois side for a distance of 2 miles from the up-stream end, a height of several feet having been added to deposits previously secured.

In the down-stream portion on the Illinois side, the results for the entire year have been small, owing to circumstances above given, but they have been very large in the last few weeks, and are, as a whole, encouraging. Plate II shows the outlines of the bars as they appeared at a stage 11 feet above standard low water at the beginning and at the end of the year. The area upon which willows are growing has been much enlarged. For further details, see Appendixes 1 and 3.

The good result of the works upon the channel previously secured has been maintained, the least depth found during the low-water season of last autumn being $8\frac{1}{2}$ feet, and the channel being direct and wide.

The expenditures during the year were \$51,473.93.

TWIN HOLLOW, WEST BANK.

Operations at this locality, the plan of which was described in my last report, were continued throughout the year, except when temporarily suspended during the winter or by the flood in June. The primary hurdle was extended down stream to a point about 11,600 feet from its up-stream end, being an addition of 2,800 feet to the length reported last year. Of this distance a portion 500 feet long being occupied by a high bar, was covered by a plantation of willows, instead of by a hurdle. The soil proved to be unfavorable and the willows died. To protect the deposits already secured at the up-stream end of the work, mattresses 104 feet wide were placed below low-water mark, and covered the space between the upper extremity of the primary line and a point 1,025 feet from it. The four secondary hurdles begun last year were repaired and extended towards the shore, and a fifth one was begun and nearly completed. The location of the works as they existed at the end of the year is shown upon Plate III. (For details, see Appendixes 1 and 4.)

Large deposits have been secured within the area to be reclaimed. Although much remains to be done in this direction, the channel has been prevented from splitting up, and the result has been of benefit to navigation.

The least depth found during the year was 8 feet. The channel crossing at the lower end of the works was pushed down-stream about 1,600 feet, which is a marked gain in the effort to straighten it.

The expenditures were \$93,136.91.

TWIN HOLLOW, EAST BANK.

In the work of protecting the Illinois bank at Twin Hollows, the slope below low-water mark had at the beginning of the year been covered

with mattresses 120 feet wide for a distance of 5,925 feet, and riprap had been deposited upon the bank above low water for a distance of 2,350 feet. A mattress in process of construction and not sunk had reached a length of 964 feet. The work was continued until October, when, having advanced as far as it was then advisable to carry it, it was suspended. The mattress, of which 964 linear feet had been constructed, was extended to a total length of 1,500 feet, and then placed in position. An additional mattress 1,210 feet long was fabricated and placed, and completed the low-water protection. As the bank above low water became graded to a gentle slope by the action of the river after the placing of the low-water mattress, riprap was deposited upon it, over the entire length of the mattress work. The height to which the riprap, or "medium stage protection," was carried, was not in all cases as great as will eventually be required, it being governed by the height to which the gentle slope extended. The total length of bank protected is 8,625 feet, of which about 2,800 feet has the riprap placed to a height 16 feet above standard low water, 2,300 feet to a height 14 feet, 1,325 feet to a height 12 feet, and 2,200 feet to a height 10 feet above the same plane. (See Plate IV.) (For further details, see Appendixes 1 and 5.)

The work has advanced beyond the limits of the caving bank, and has been completely successful in arresting the caving.

The expenditures during the year were \$42,613.15.

PULLTIGHT.

The construction of a hurdle to connect the Illinois shore near Pulltight with the head of Beard's Island constituted a part of my project of January 28, 1881, for the improvement of the river between Carroll's Island and the mouth of the Meramec, the object being to connect Beard's Island and the tow-head above it with the main shore—see Plate III—thus building out the Illinois bank to the line indicated, and in connection with the works at Twin Hollows, west bank, reducing the width of the river.

A primary hurdle 2,860 feet long was constructed, and secondary hurdles Nos. 1 and 3 were begun. No. 3 was completed to its intersection with the towhead as the latter existed last autumn. The extraordinary series of westerly gales already referred to caused a rapid erosion of the towhead during the spring, and has increased the amount of work that will be required here. No. 1 had made but little progress when it was temporarily suspended by high water in June. Deposits have been secured to a satisfactory degree by the works constructed. They have aided in obtaining the beneficial results to navigation at Twin Hollows, before referred to. (For details, see Appendixes 1 and 6.)

The expenditures were \$46,465.47.

BEARD'S ISLAND.

The revetment of the west side of Beard's Island was continued. At the beginning of the year the slope below low-water mark had been covered with mattresses 120 feet wide for a distance of 3,550 feet, beginning at the head of the island, and riprap had been deposited upon the bank above low water for a distance of 1,650 feet. A mattress in process of construction had reached a length of 550 feet, but no portion of it had been sunk. Early in July an attempt was made to place this mattress in position, but it failed and the mattress was lost. This dis-

aster was followed by others. (See Appendix 7.) The difficulties to be contended with were exceptionally great, but believing them to be not insuperable I was unable to acquit the resident engineer of a responsibility for the repeated failures, and accordingly in October relieved him from further duty at the work, placing his assistant in charge. From that time forward the progress was continuous, though slow. During the season the protection below low-water mark was extended downstream 3,850 feet, making its total length 7,300 feet, which covered the entire length of the island and a portion of the chute below, the latter having been filled up by deposits caused by the works near Pulltight. Riprap was deposited upon the bank above low water for a length of 3,500 feet. Of this, 850 feet was carried to a height 16 feet above standard low water, thus completing it; the remainder was carried to a height of about 6 feet above that plane. To complete the work it will be necessary to place the medium stage protection over a distance of 2,150 feet where no riprap has been placed, and to extend it up the face of the bank over a distance of 2,650 feet, where it has been partially placed. It is uncertain whether it will be necessary to plant willows for the high-water protection or not. All undermining and caving of the bank has been completely stopped. (For further details, see Plate V and Appendixes 1 and 7.)

The expenditures were \$55,810.47.

CHESLEY ISLAND.

The revetment of the east side of Chesley Island and the closure of the chute on its west side constituted parts of my project of September 12, 1881, for the improvement of the river between the mouth of the Meramec and Illinois Station.

The case presented for the bank protection on the east side was that of a crossing, where the channel strikes the bank at an obtuse angle, necessitating a wide and deep protection.

The width of the mattress to be placed below low-water mark was fixed at 120 feet as in all similar cases. A single mattress 4,305 feet long was fabricated and placed in position covering so much of the island as required protection on that side. (See Plate VI.) This mattress, measuring 120 feet by 4,305 feet, or 516,600 square feet, is the largest yet constructed under my direction. It might have been made longer had any additional length been required. Riprap was deposited upon the bank above low water for a distance of 3,900 feet, of which 3,475 feet was carried to a height 16 feet above standard low water, the remaining 425 feet being carried only to a height 6 feet above that plane. To complete this part of the work it remains to place the medium stage protection for a distance of 564 feet where no riprap has been placed, and to extend it up the face of the bank for a length of 425 feet.

A revetment was placed also at the head of the island, extending in towards the chute. In this case a less width of mattress was considered sufficient. A mattress 40 feet wide and 550 feet long was placed below low-water mark, and riprap deposited upon the bank throughout this length.

A hurdle about 900 feet long to close the chute west of the island was begun and nearly completed. (See Plate III.)

The bank protection has been as successful here as it has elsewhere, all undermining and caving having been completely stopped. The hurdle has not as yet had time to accomplish any important result. For further details see Appendixes 1 and 8.

The expenditures were \$47,401.39.

"JIM SMITH'S."

Operations at this locality were continued during the summer and autumn of 1882, in accordance with the plan described in my last annual report. (See Plate III.) At the beginning of the year the only work which had been done was the partial construction of the primary hurdle, which reached a length of about 1,000 feet. During the season this hurdle was extended down stream to a point 8,650 feet from the original point of beginning. Of this distance about 3,300 feet was occupied by a sand bar which was planted with cottonwood and willows. Six secondary hurdles were begun, of which numbers 1 and 5 were completed, and the others well advanced, the total length of secondary hurdles constructed being 7,600 feet.

The hurdles were much injured by ice in the break-up this spring. About 68 per cent. were reported to be in good condition afterwards. Contingencies of this kind bring the final cost of work done during the low-water season of the autumn well up towards that of work done in the spring, when the high water increases the difficulties of construction, but at the same time gives more prompt results in the shape of deposits.

Owing to the fact that no additional appropriations were made at the last session of Congress, work was not continued here in the latter half of the fiscal year, the available force being required elsewhere. It will be resumed as soon as this force can be spared from other work, which it is expected will be in August, 1883.

Considerable deposits have been secured within the area to be reclaimed, and the effect upon the channel has been beneficial. The least depth found during the year was $8\frac{1}{2}$ feet, though this was partially to be attributed to the damming effect of a bad shoal at Sulphur Springs, just below. For details see Appendixes 1 and 9.

The expenditures were \$103,418.37.

FOSTER'S ISLAND.

The revetment of the west side of Foster's Island constituted part of my project of September 12, 1881, for the improvement of the river between the mouth of the Meramec and Illinois Station, approved by your letter of November 2, 1881. During the summer of 1882 the bank caved with great rapidity, the shore line receding, in some cases, several hundred feet from the position occupied in 1881. The case presented was one requiring a wide and deep protection. The demands of other works rendered it impossible to begin this work until late in the season. One mattress 580 feet long was fabricated and sunk. The reduction of the force necessitated by the failure of additional appropriations rendered it impracticable to continue the work in the spring. It is expected that it can be resumed in a short time. So far as it extended, it had the desired result of arresting the undermining of the bank. For details see Appendix 10.

The expenditures were \$5,779.18.

PIASA ISLAND.

In my project of August 26, 1880—see Annual Report of Chief of Engineers for 1881, page 1566—it was explained that it would be neces-

sary to remove a portion of the dam built across the chute south of Piasa Island by my predecessor in 1875-'77. Before that project could be carried into effect the funds available for its execution were by the river and harbor act of March 3, 1881, diverted to the improvement of Alton Harbor. Accordingly nothing was done at Piasa Island. The difficulty of navigating the north chute continued to increase until finally the high water of 1882 moved a large bar down over the mouth, shutting it off altogether during the succeeding low water. Steamboats were compelled to find their way through the south chute, seeking such depressions as existed in the dam for a passage over it. This became more and more dangerous as the stage of the river declined. A suspension of navigation at this point was threatened. Under these circumstances it was thought proper to depart from the programme previously laid down for the expenditure of the appropriation, and to allot to Piasa Island funds sufficient to make a safe passage-way through the dam.

It was found upon examination that the most suitable place for the opening was at the south end of the dam near the Missouri shore. An attempt was made to undermine the dam with the hydraulic excavator belonging to the works, arranged as in a Roy Stone dredge, but owing to the great depth—20 feet—of the foundation, it was not successful. The contrivance showed its efficiency as an excavator, however, raising in some cases 1,000 cubic feet of sand per hour. An arrangement was then made with Messrs. H. S. Brown & Co., of Quincy, Ill., to remove the dam, using the ordinary dredge. A cut was made, having a width of 385 feet and a least depth of 6 feet at low water, after which there was no obstacle to navigation at this place. For details see Appendix 11.

The expenditures were \$2,750.11.

ALTON HARBOR.

The improvement of Alton Harbor was begun in September, 1881, under a separate appropriation for the "Improvement of the harbor and Mississippi River at Alton." My annual report of last year under that title—see Annual Report of Chief of Engineers for 1882, page 1644—gives a description of the plan adopted and the history of the operations up to that time. A dike opposite and above the town, running obliquely down-stream, had been begun, and was about one-third completed.

The river and harbor act of August 2, 1882, made provision for the improvement of the Mississippi River in the following language, viz :

* * * * *

Six hundred thousand dollars from Cairo to the Illinois River, including Alton Harbor, on which a sum not exceeding thirty-five thousand dollars shall be expended.

Work was accordingly begun in September, 1882, under this appropriation. It consisted of extending and raising the dike begun under the special appropriation.

The dike was extended to the full length contemplated, 4,800 feet. For a distance of 3,000 feet it was raised to its full height, 14 feet above low water; for a distance of 700 feet its height is 12 feet, and for the remaining 1,100 feet its height is but 10 feet above the same plane. To complete it as originally designed, it should be raised to the uniform height of 14 feet throughout, but it is not now certain that this will be necessary. It has exerted a very favorable influence upon the landing

at Alton, and as this action is still continuing, it is quite possible that the desired result will be attained without further work.

The work upon this dike has been carried on during three distinct periods, viz, the autumn of 1881, the spring of 1882, and the autumn of 1882. The amount accomplished during the first period was small, owing to unexpected floods, which occurred during what is usually the low-water season. About 3,500 cubic yards of dike were constructed, at a cost of \$2.90 per cubic yard. During the second period the river was at about the average spring stage; the amount of work accomplished was about 20,200 cubic yards of dike, at a cost of \$1.10 per cubic yard. During the third period the season was favorable, and the river was at a low stage; the amount accomplished was about 35,000 cubic yards, at a cost of 97 cents per cubic yard. Here is an excellent illustration of the contingencies to be met with in carrying on work upon the Mississippi River. Work which, under favorable circumstances, cost 97 cents per cubic yard, cost, under other circumstances, \$2.90, or three times as much. The character of the work during the two periods was the same, and the season of the year was the same. The only difference in the circumstances came from the operations of nature, which could not be foreseen. It is plain that all estimates of cost made in advance can be no more than approximations.

For details of the work, see Appendix 12.

The expenditures were \$34,000.

SUPPLY DEPOT.

For the better protection of the public property from petty depredators a board fence was constructed upon the northern and western sides of the yard, at a cost of \$160 34. All of the smaller material used upon the works, such as rope, iron, wire, spikes, &c., and all subsistence stores were stored at the depot and issued as required. Many miscellaneous constructions and repairs were made, for details of which see Appendixes 1 and 13.

EQUIPMENT.

The hull of the steamer Anita having become unserviceable, her machinery was transferred to a new hull built for the purpose by Messrs. Howard & Co., at Jeffersonville, Indiana. The new boat has been named the General Gillmore. She is 140 feet long and 28 feet wide, and has been provided with every convenience for doing the work required of her. Her total cost, including three new steel boilers and outfit, thorough repair of the old machinery, and renewal of certain parts of it, was \$20,171 24. The other principal additions to the equipment during the year were the construction of twenty-two portable buildings for quarters, &c., and nineteen small flats and the purchase of three second-hand coal barges.

A special record is kept in which the equipment is treated as so much unexpended appropriation. Each work is charged for the use and repair of such as may be employed upon it. The amounts given in this report as expended at each locality include the wear and tear of equipment.

The present valuation of the property remaining to be distributed in the future is given in the last column of the following table, in which are given also its valuation at the beginning of the year, the sums which

have been expended upon it, and its estimated deterioration during the year.

Class of property.	Balance July 1, 1882.	Debits.	Credits.	Balance June 30, 1883.
Steamer A. A. Humphreys.....	\$21,198 16	\$3,439 17	\$3,846 77	\$20,791 56
Steamer Anita.....	2,910 22		2,910 22	
Steamer General Gillmore.....		22,081 46	221 21	21,860 25
Launch Hornet.....	106 56	230 44	230 44	106 56
Launch Florence.....		1,625 64	725 64	900 00
Tug Mignon.....	4,077 72			4,077 72
Barges.....	82,507 37	7,873 68	28,273 68	62,107 37
Pile-drivers.....	55,420 83	4,238 85	9,842 53	49,817 15
Quarter-boats, quarters, shops, &c.....	41,699 46	9,491 51	6,485 30	44,705 67
Skiffs, flats, &c.....	18,090 57	4,791 94	5,785 98	12,036 58
Tools and appliances.....	7,241 00	19,689 97	11,482 78	15,448 19
Hydraulic excavator.....	7,458 33	861 36	614 72	7,204 87
Ways for mattresses.....	5,711 09	468 34	847 74	5,331 09
Office furniture.....	913 36	532 35	258 50	1,177 21
Surveying instruments.....	1,751 86	44 65	364 85	1,431 66
Boarding outfit.....	12,358 95	4,092 73	1,398 61	15,065 07
Total.....	256,396 48	78,951 99	73,276 92	203,061 55

TELEPHONE LINE.

The telephone line constructed last year to the mouth of the Meramec was extended to Bushberg for the purpose of communicating with the work at Foster's Island. The price agreed upon with the Bell Telephone Company of Missouri for this extension was \$1,932 for the first year and \$655.20 for each succeeding year.

SUBSISTENCE.

The methods adopted for providing the force with subsistence are described in Appendix 14. The average cost of subsistence for each man per day during the spring of 1883 was 44 cents, including all expenses connected with the purchase, issue, and preparation of the supplies.

PILE-DRIVING.

As the driving of piles constitutes the largest single item of expense in the works of construction, it is important that the machines used for that work and the organization of the men engaged in it should be as perfect as possible. First Lieut. F. V. Abbot, Corps of Engineers, was assigned by my order of June 10, 1882, to a special study of the art of pile-driving in sandy soils, and made an elaborate series of observations, from which some interesting and valuable conclusions may be drawn. He ascertained that of \$38,689.95 expended for labor in driving 20,000 piles, \$14,255.94 was consumed in placing the driver in position. The conclusion is that a driver which will require least moving will, other things being equal, be most economical; or, in other words, that a driver furnished with several sets of leads promises good economical results. After careful observation of the steam hammer in use upon pile-drivers working at Chicago, Lieutenant Abbot concluded that there was little or no advantage in that form of hammer. He ascertained that the rapidity of penetration of piles sunk by the water-jet and hammer combined is remarkably uniform when the average of a great number of piles is considered, and when the depth does not exceed 16 feet, the rate being about the same for the last 2 feet as for the first two. His report is given in full as Appendix 15.

GAUGES.

The gauges at Grafton and Gray's Point were read daily. Their records are appended marked 16 and 17, respectively. The gauge at Alton was discontinued, it having been observed sufficiently long to give with accuracy the slope of the river between the mouths of the Illinois and Missouri, and there being no other necessity for a gauge so near to that at Grafton.

NAVIGABLE DEPTH BETWEEN SAINT LOUIS AND CAIRO.

The reports made to the association of Saint Louis and New Orleans pilots by its members have been transferred to me as in former years, and from them has been made a record of the depths found upon the bars between Saint Louis and Cairo throughout the year. So much of it as covers the low-water season is herewith transmitted, marked 18. As explained in former reports, strict accuracy is not claimed for any one measurement. The record, to be of value, should be taken as a whole; several day's measurements, and the gauge records, being considered together. The low-water season extended from a little after the middle of August until navigation was suspended by ice in December. The lowest stage reached was 1.9 feet above standard low water. The least depth reported and not contradicted was 5 feet and was found at Sulphur Springs, Forest Home, Kinney Point, and Jacket Pattern. A depth of $5\frac{1}{2}$ feet was found at Cornice Island, Perry T. H., Liberty Island, and Crawford's. In all cases the least depth was found in October when the river was at a stage more than 3 feet above standard low water. The least depth found throughout the $21\frac{1}{2}$ miles of river between Saint Louis and Kimmswick over which the works of improvement have extended was 8 feet.

MISSISSIPPI RIVER COMMISSION.

The river and harbor act of August 2, 1882, required that the sums appropriated by that act for improving the Mississippi River below the Des Moines Rapids should "be expended by the Secretary of War in accordance with the plans, specifications, estimates, and recommendations of the Mississippi River Commission created by the act approved June 28, 1879, or according to such plans, specifications, and estimates of the Engineer Department of the Army, which, having been approved by the Secretary of War, may be adopted by the said Mississippi River Commission for such parts of the said river as the said commission may not have completed the survey of." In compliance with your instructions of August 28, 1882, I submitted my plans and a copy of my project for the expenditure of the \$600,000 appropriated for the Mississippi from Cairo to the Illinois River, by the act referred to, to the commission with a letter dated September 6, 1882. At their session of September 13-18, 1882, the commission approved and adopted the project, and a copy of their resolution to that effect was furnished me with your letter of September 26, 1882. In the mean time the works were progressing, and they have since continued without change in their administration.

ESTIMATE.

The estimate for the entire completion of the improvement which has been given in the annual reports from this office was made in 1875. The methods of construction upon which it was based proved inefficient

and were abandoned in 1879. There being no sufficient data for making an accurate estimate under the new methods of construction, the original estimate has, up to this time, been retained. The available data are not even now sufficient for an estimate which shall be entirely reliable, but it has become evident that the original estimate is too small. To avoid misleading Congress it is necessary to state this fact, and to make a new estimate which shall be as nearly accurate as present information will allow.

The contingencies of work upon the Mississippi are so great that any estimate based upon the number of linear feet of hurdle or other construction to be built, and the cost per linear foot, may be very erroneous. The original cost per linear foot may vary between wide limits, depending upon the weather and the stage of the river. By taking an average of several seasons an approximation to this cost may be reached, but the number of times that the silting devices may have to be repaired, or even entirely rebuilt, at any particular spot is uncertain. Evidently the only way to reach an accurate estimate is to take the cost per mile of some portion of the river which has been the subject of improvement for a number of years, where the circumstances are in general the same as those to be met with hereafter, and where the works have been entirely completed. There is at this time no portion of the river which fulfills all of these conditions. The present system of construction was first introduced at Horsetail in 1879. All other works of the same general character are of more recent date, the oldest of them, those at Twin Hollows, having been begun in the autumn of 1881. The works at Horsetail are further advanced towards completion than any others, and, though defective as a basis for estimating future cost, are the best for that purpose that exist.

The total amount that has been expended upon the improvement of the 5 miles of river known as Horsetail, under the present system and not including the cost of the original stone jetties, is \$367,901.95. This includes \$12,038.69 expended upon the protection of the west side of Carroll's Island. During the first two years of this work the forms of construction were largely experimental, they were undergoing modification, and their cost was larger than it would be again under the same circumstances of weather and river. To accomplish the same result \$350,000 would now perhaps be sufficient. The desired effect upon navigation has been attained, a wide, deep, and direct channel having been procured, but it remains to secure these results by further building up of the new banks and consolidating and protecting the new land. The cost of this is the uncertain element in the present problem. I estimate it at not less than \$25,000 per year for three years, or \$75,000 in all, to be added to the \$350,000 already expended. This gives a total of \$425,000 for improving 5 miles of river, or \$85,000 per mile. The forms of construction upon which it is based are applicable to the part of the Mississippi below the Missouri.

Between the Missouri and the Illinois other forms are used, and all circumstances of foundation, velocity of current, &c., are different. For this part of the river \$37,500 per mile would, I think, be a reasonable estimate.

The distance from the mouth of the Missouri to the mouth of the Ohio is 205 miles. Of this distance 18 miles, from Gingrass Creek to the foot of Carroll's Island, has been improved; 14 miles from Carroll's Island to Bushberg, and 5 miles from Minton Point to Cape Girardeau will reach a stage of improvement with funds now available, which may, for present purposes, be considered half done, and about 16 miles in all

will not need improvement. These aggregate 43½ miles, leaving 161½ miles to be improved, which, at \$85,000, will cost \$13,327,500.

The distance from the mouth of the Illinois to the mouth of the Missouri is 24½ miles. The improvement of Alton Harbor has improved the general navigation for about 2½ miles, leaving 22 miles to be improved. This, at \$37,500, will cost \$825,000.

The total amount required for improving the Mississippi from the Illinois to the Ohio is therefore estimated at \$14,152,500.

The amount which can be profitably expended during the year ending June 30, 1885, is \$1,000,000. It is proposed to expend it in carrying out the programme heretofore adopted. This is to first improve the part of the river below Saint Louis, to make the improvement continuous, beginning at Saint Louis and working down stream, reclaiming land and building up new banks, thus reducing the river to the approximately uniform width of about 2,500 feet. It is proposed by this means to secure a channel depth of at least 8 feet at the lowest stage. The depth is now liable to become as little as 4 feet or even less in some places, and less than 8 feet in every place where the width is greater than 2,500 feet. Alluvial banks are to be protected from erosion. This general statement of the proposed application of the appropriation is as specific as the nature of the case will admit of. The changeable character of the river renders it impracticable to give in advance the exact localities where works will be required.

The work is located in the collection district of New Orleans.

Amount of revenue collected at the port of Saint Louis for the fiscal year ending June 30, 1883, was \$1,393,744.56.

Money statement.

July 1, 1882, amount available.....	\$112, 145 18
Miscellaneous receipts.....	86 64
Amount appropriated by act passed August 2, 1882.....	600, 000 00
	<hr/> 712, 231 82
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$510, 995 09
July 1, 1883, outstanding liabilities.....	5, 991 15
	<hr/> 516, 986 24
July 1, 1883, amount available	195, 245 58
	<hr/> 14, 152, 500 00
Amount (estimated) required for completion of existing project	14, 152, 500 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	1, 000, 000 00

Construction account.

Name of work.	Expended prior to July 1, 1882	Expended during fiscal year ending June 30, 1883.	Total cost to June 30, 1883.
Piassa Island Dam	\$32, 333 30		\$32, 333 30
Piassa Island Dam, removing		\$2, 750 11	2, 750 11
Alton Dam	33, 623 92		33, 623 92
Alton Dike	33, 324 70	34, 000 00	67, 324 70
Sawyer Bend protection	96, 803 63		96, 803 63
Venice Dikes	86, 341 85		86, 341 85
Arsenal Island protection	24, 196 78	6, 535 92	30, 732 65
Closing Cahokia Chute	116, 088 60		116, 088 60
Channel opposite Saint Louis		40, 873 88	40, 873 88
Horseshall Bar:			
Dike 1.....	40, 549 53		40, 549 53
Dike 2.....	23, 600 26		23, 600 26
Dike 3.....	82, 692 54		82, 692 54
Dike 4.....	41, 290 11		41, 290 11

Construction account—Continued.

Name of work.	Expended prior to July 1, 1882.	Expended during fiscal year ending June 30, 1883.	Total cost to June 30, 1883.
Horsetail Bar:			
Dike 5.....	\$36,933 87		\$36,933 87
Training-wall.....	80,627 03		80,627 03
Primary hurdles.....	304,389 33	\$51,473 98	355,863 36
Secondary hurdles.....			
Twin Hollows, west bank:			
Primary hurdle.....	103,500 25	93,136 91	196,637 16
Secondary hurdle.....			
Twin Hollows, east bank, bank protection	72,606 63	23,232 81	95,838 94
Beard's Island:			
Primary hurdle.....	7,166 24		7,166 24
Bank protection.....	28,448 29	55,810 47	84,258 76
Jim Smith's:			
Primary hurdle.....	11,068 37	103,418 37	114,486 74
Secondary hurdle.....			
Pulltight:			
Primary hurdle.....		46,465 47	46,465 47
Secondary hurdle.....			
Chealey Island, bank protection		47,401 39	47,401 39
Foster's Island, bank protection		5,779 18	5,779 18
Fort Chartres Dam	36,812 86		36,812 86
Turkey Island	24,463 85		24,463 85
Kankakee protection	66,465 62		66,465 62
Liberty Island:			
Dam.....	5,053 91		5,053 91
Protection.....	45,129 40		45,129 40
Devil's Island:			
Dike 1.....	65,871 17		65,871 17
Dam 1.....	49,848 58		49,848 58
Dam 2.....	16,678 30		16,678 30
Minton Point:			
Primary hurdle.....	33,436 37		33,436 37
Secondary hurdle.....			
Cape Girardeau, primary hurdle	10,098 59	21,836 59	31,930 18
Cairo protection	119,868 66		119,868 66
	1,679,397 49	532,714 53	2,212,112 02

Property and material account.

Class of property.	Balance, July 1, 1882.	Debits.	Credits.	Balance, June 30, 1883.
Steamer Humphreys and expenses	\$21,199 16	\$22,723 45	\$23,181 05	\$20,791 56
Steamer Anita	2,910 22	7,191 32	10,101 54	
Steamer General Gillmore and expenses		22,081 46	221 21	21,860 25
Launch Hornet and expenses	106 56	1,383 97	1,383 97	106 56
Tug Mignon	4,077 72			4,077 72
Launch Florence and expenses		3,354 99	2,454 99	900 00
Barges	82,507 87	14,437 75	34,837 75	62,107 87
Barge Flats				
Pile-drivers	55,420 83	12,810 28	18,413 96	49,817 15
Quarters, shops, &c	84,173 48	10,226 98	11,970 77	38,429 69
Carrier boats	7,525 98	202 30	1,452 30	6,275 98
Skiffs, &c.	13,030 57	5,402 87	6,396 86	12,036 58
Tools and appliances	7,241 00	19,582 65	11,375 48	15,448 19
Hydraulic excavator	7,458 33	604 47	857 93	7,204 87
Ways for mattresses	5,711 09	585 53	964 93	5,331 69
Boarding outfit	12,358 95	5,382 36	2,676 24	15,065 07
Subsistence, &c.	4,701 02	66,980 30	67,560 87	4,120 45
Photographic apparatus		785 28	445 77	336 51
Office furniture	913 86	522 35	258 50	1,177 21
Surveying instruments	1,751 86	44 65	364 85	1,431 66
Material:				
Brush.....	3,929 26	71,218 99	72,118 02	3,030 23
Piles.....	7,711 34	15,151 63	69,437 26	9,425 71
Stone.....	524 78	39,813 47	38,794 08	1,544 17
Miscellaneous.....	11,513 42	35,788 11	33,710 81	13,590 72
Brush, Minton Point.....	755 95	3,190 80	3,946 75	
Piles, Minton Point.....	2,134 55	1,177 36	3,311 91	
Stone, Minton Point.....	789 55	1,306 52	2,096 07	
Stone, Little Rock.....	1,581 99			1,581 99
Steamer Little Eagle, No. 2		5,255 25	5,255 25	
	290,028 84	429,205 09	423,539 10	296,694 83

1190 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of proposals for furnishing piles at Government works in Mississippi River between Saint Louis, Mo., and Harrisonville, Ill., received in response to advertisement dated December 15, 1882, and opened January 15, 1883, by Maj. O. H. Ernst, Corps of Engineers.

No.	Names and addresses of bidders.	3,500 piles, 30 to 35 feet.		5,000 piles, 35 to 45 feet.		1,500 piles, 45 to 60 feet.		Total.
		Price.	Amount.	Price.	Amount.	Price.	Amount.	
		<i>Per ft.</i>		<i>Per ft.</i>		<i>Per ft.</i>		
1	William H. Doza, Kaaskasia, Ill.	\$0 06	\$6,300	\$0 06	\$10,500	\$0 07	\$4,725	\$21,525
2	John Cleary, Chester, Ill.	6½	6,825	7	12,250	8	5,400	24,475
3	Thomas A. Walker, Saint Louis, Mo.	7	7,350	7½	13,125	8	5,400	25,875
4	Ashton P. Johnson, Saint Louis, Mo.	7	7,350	8	14,000	9	6,075	27,425

Abstract of proposals for furnishing riprap on board Government barges in the Mississippi River within a distance of 100 miles from Saint Louis, Mo., received in response to advertisement dated December 15, 1882, and opened January 15, 1883, by Maj. O. H. Ernst, Corps of Engineers.

No.	Names and addresses of bidders.	25,000 cubic yards riprap.		Distance of quarry above Saint Louis or below Bushberg.	Amount added to bid for distance, at one-quarter cent per mile.	Price, as amended, for distance.	Total.
		Price.	Amount.				
		<i>Per cubic yard.</i>		<i>Miles.</i>	<i>Per cu. yd.</i>	<i>Per cu. yd.</i>	
1	Haas & Steins, Crystal City, Mo.	\$0 50	\$12,500	6	\$0 01½	\$0 51½	\$12,875 00
2	Jas. Black, president, and J. S. Roper, secretary Grafton Quarry Company, Grafton, Ill.	48	12,000	38	9½	57½	14,375 00
3	John C. Salter, warden, Chester, Ill.	47	11,750	51	12½	59½	14,937 50
4	Lorenz & Weige, Saint Louis, Mo.	62	15,500	29	7½	62	15,500 00
5	Wm. K. Patrick, Little Rock, Mo.	74	18,500			81½	20,312 50

Abstract of proposals for furnishing annealed iron wire at United States Engineer Depot, foot of Arsenal street, Saint Louis, Mo., received in response to advertisement dated December 15, 1882, and opened January 15, 1883, by Maj. O. H. Ernst, Corps of Engineers.

No.	Names of bidders.	9,500 pounds wire No. 10.		22,500 pounds wire No. 12.		8,000 pounds wire No. 14.		Total.
		Price.	Amount.	Price.	Amount.	Price.	Amount.	
		<i>Per lb.</i>		<i>Per lb.</i>		<i>Per lb.</i>		
1	H. L. Fox & Co., Saint Louis, Mo.	\$0 24½	\$497 55	\$0 04½	\$999 00	\$0 04½	\$390 00	\$1,796 55
2	Alfred Clifford, secretary and treasurer, Saint Louis, Mo.	4½	418 00	4½	1,012 50	5	400 00	1,830 50
3	M. M. Buck & Co., Saint Louis, Mo.	4½	413 25	4½	1,035 00	5	400 00	1,848 25
4	Paul J. Field, Philadelphia, Pa.	5½	494 00	5½	1,209 38	5½	460 00	2,163 38

Abstract of proposals for furnishing spikes, iron, and nails at the United States Engineer Depot, foot of Arsenal street, in Saint Louis, Mo., received in response to advertisement dated December 15, 1882, and opened January 15, 1883, by Maj. O. H. Ernst, Corps of Engineers.

No.	Names of bidders.	17,000 pounds spikes, 8 by $\frac{3}{4}$ inch.		11,000 pounds spikes, 6 by $\frac{3}{4}$ inch.		2,000 pounds iron, $\frac{3}{4}$ inch diam.		3,200 pounds iron, $\frac{3}{4}$ inch diam.		800 pounds iron, $\frac{1}{2}$ inch diam.		
		Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	
*1	M. M. Buck & Co., Saint Louis, Mo.	Per lb. \$0 02 15	\$335 50	Per lb. \$0 04 15	\$456 50	Per lb. \$0 02 5	\$56 00	Per lb. \$0 02 5	\$63 20	Per lb. \$0 02 4	\$19 20	
2	Waterman, Campbell & Co., Saint Louis, Mo.	03 25	532 50	04 1	451 00	02 9	58 00	02 5	86 40	02 5	20 00	
3	H. L. Fox & Co., Saint Louis, Mo.	03 29	559 30	04 24	466 40	02 89	57 80	02 69	86 08	02 49	19 92	
4	Ward & Brady, Saint Louis, Mo.	03 15	535 50	04 1	451 00	03	60 00	02 8	89 60	02 5	20 80	
5	E. E. Souther & Bro., Saint Louis, Mo.	03 4	578 00	04 3	473 00	03	60 00	02 8	89 60	02 5	20 80	
†6	Morris J. Lippman, Saint Louis, Mo.					02 9	56 00	02 7	86 40	02 5	20 00	
No.	Names of bidders.	14,000 pounds iron, $\frac{3}{4}$ inch diam.		500 pounds iron, $\frac{3}{4}$ inch diam.		30,000 pounds iron, 1 inch diam.		900 pounds nails, 10d.		2,600 pounds nails, 20d.		Total.
		Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	
*1	M. M. Buck & Co., Saint Louis, Mo.	Per lb. \$0 02 3	\$322 00	Per lb. \$0 02 3	\$11 50	Per lb. \$0 02 2	\$660 00	Per lb. \$0 03 5	\$31 50	Per lb. \$0 03 5	\$91 00	\$2,266 40
2	Waterman, Campbell & Co., Saint Louis, Mo.	02 4	336 00	02 4	12 00	02 3	660 00	03 5	32 40	03 5	98 60	2,331 90
3	H. L. Fox & Co., Saint Louis, Mo.	02 39	334 60	02 39	11 95	02 29	657 00	03 35	30 15	03 35	87 10	2,340 30
4	Ward & Brady, Saint Louis, Mo.	02 5	350 00	02 5	12 50	02 4	720 00	03 59	32 31	03 59	93 34	2,365 05
5	E. E. Souther & Bro., Saint Louis, Mo.	02 5	350 00	02 5	12 50	02 4	720 00	03 8	34 20	03 8	96 80	2,456 90
†6	Morris J. Lippman, Saint Louis, Mo.	02 4	336 00	02 4	12 00	02 3	660 00					1,202 40

* Rejected; surties not certified.

† Partial bid.

Abstract of proposals for furnishing rope, steel yarn, and oakum at the United States Engineer Depot, foot of Arsenal street, in Saint Louis, Mo., received in response to advertisement dated December 15, 1882, and opened January 15, 1883, by Maj. O. H. Ernst, Corps of Engineers.

No.	Names of bidders.	1,826 pounds bolt rope, $\frac{1}{4}$ inch diam.		1,190 pounds bolt rope, $\frac{3}{8}$ inch diam.		5,900 pounds bolt rope, $\frac{1}{2}$ inch diam.		7,500 pounds bolt rope, $\frac{1}{2}$ inch diam.		6,640 pounds bolt rope, $\frac{1}{2}$ inch diam.				
		Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.			
1	Udell, Schmiedling & Co., Saint Louis, Mo.	Per lb.		Per lb.		Per lb.		Per lb.		Per lb.				
*2	M. M. Buck & Co., Saint Louis, Mo.	\$0 15.25	\$278 46	\$0 15.25	\$181 47	\$0 15.25	\$899 75	\$0 15.25	\$561 20	\$0 15.25	\$1,143 75			
3	Ward & Brady, Saint Louis, Mo.	15.2	277 55	15.2	180 88	15.2	896 80	15.2	559 36	15.2	1,140 00			
4	Samuel Cupples, Saint Louis, Mo.	16.25	297 45	16.25	193 85	16.25	961 11	16.25	599 47	16.25	1,221 75			
5	Rowland A. Robbins, New York.	16.25	296 72	16.25	193 37	16.25	958 75	16.25	598 00	16.25	1,218 75			
16	W. H. Langdale, manager Anchor Line store, Saint Louis, Mo.	16.74	305 67	16.74	199 21	16.74	987 66	16.74	616 03	16.74	1,256 50			
		16.68	304 58	16.68	198 49	16.68	984 12	16.68	613 82	16.68	1,251 00			
											\$1,012 60			
											1,009 28			
											1,081 66			
											1,079 00			
											1,111 54			
											1,107 55			
No.	Names of bidders.	3,615 pounds bolt rope, $\frac{1}{2}$ inch diam.		3,500 pounds sisal rope, $\frac{3}{8}$ inch diam.		5,000 pounds sisal rope, $\frac{1}{2}$ inch diam.		12,000 pounds sisal rope, $\frac{1}{2}$ inch diam.		7,000 pounds sisal yarn, 2-ply.		2,000 pounds oakum.		Total.
		Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	
1	Udell, Schmiedling & Co., Saint Louis, Mo.	Per lb.		Per lb.		Per lb.		Per lb.		Per lb.		Per lb.		
*2	M. M. Buck & Co., Saint Louis, Mo.	\$0 15.25	\$551 29	\$0 10	\$350 00	\$0 09 50	\$475 00	\$0 08 50	\$1,140 00	\$0 09 50	\$665 00	\$0 09 40	\$188 00	\$7,446 52
3	Ward & Brady, Saint Louis, Mo.	15.2	549 48	10	350 00	10	500 00	10	1,200 00	10	700 00	09 1	182 00	7,545 25
4	Samuel Cupples, Saint Louis, Mo.	16.25	598 88	09 69	329 15	09 20	460 00	09 20	1,104 00	09 20	644 00	08 12 $\frac{1}{2}$	182 50	7,653 82
5	Rowland A. Robbins, New York.	16.25	587 44	09 8	343 00	09 20	465 00	09 30	1,116 00	09 30	651 00	09	180 00	7,687 03
16	W. H. Langdale, manager Anchor Line store, Saint Louis, Mo.	16.74	605 15	09 95	348 25	09 45	472 50	09 45	1,134 00	09 45	661 50	08 94	178 80	7,875 81
		16.68	602 98											5,062 54

* No sureties.

† Partial bid; no bidder's bond.

1.

REPORT OF MR. D. M. CURRIE, ASSISTANT ENGINEER.

SAINT LOUIS, MO., July 19, 1883.

SIR: I have the honor to transmit herewith the annual reports for the year ending June 30, 1883.

Part I. Upon works chargeable to the general appropriation for the "improvement of the Mississippi River between Cairo and the Illinois River."

Part II. Upon works chargeable to the appropriation for the "improvement of the channel of the Mississippi River opposite the city of Saint Louis, Mo."

Very respectfully, your obedient servant,

D. M. CURRIE,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

I.—IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN CAIRO AND THE ILLINOIS RIVER.

INTRODUCTION.

Localities.—In making the improvements under the general appropriation from Cairo to the Illinois River, to which these reports relate, work has been carried on at Arsenal Island, Horsetail Bar, Twin Hollows (west side), Twin Hollows (east side), Pulltight, Beard's Island, Chesley Island, and "Jim Smith's."

Organization.—The basis of the organization of the administrative staff in the field was adopted during the preceding year. At the close of this year the assignments of resident engineers and their assistants were:

At Arsenal Island, Mr. C. D. Lamb, assisted by Mr. Gerald Bagnall and Mr. E. F. Officer.

At Horsetail Bar, Mr. E. D. Libby, assisted by Mr. C. P. Mitchell and Mr. S. B. Cady.

At Twin Hollows, west side, Mr. W. S. Mitchell, assisted by Mr. J. L. Duffy.

At Twin Hollows, east side, Pulltight, and Jim Smith's, Mr. J. O. Holman, assisted by Mr. A. F. Freis and Mr. B. E. Johnson.

At Beard's Island, Mr. J. E. Savage.

At Chesley Island, Mr. C. V. Mercereau, assisted by Mr. J. W. Irwin.

The construction and repair of equipment at the supply depot was under the supervision of Mr. C. L. Stevenson, clerk; and Mr. J. L. Stubblefield, assistant engineer, acted as general receiver of materials on board the steamer General Gillmore.

Accompanying reports.—Reports of resident engineers, and the clerk at the supply depot, submitted herewith, are intended to form a part of this report, to which special reference is made for an historical account of the operations and statements of expenditures on account of labor and material in detail. All the assistants are entitled to credit for zealous devotion to their work, and faithful performance of duty.

ARSENAL ISLAND.

Field-work was resumed about the middle of August, after having been suspended from June 30 of the preceding year, because the island was submerged.

Low-water protection.—Sixty-five guide piles were driven and 1,003 linear feet of mattress constructed and placed in extending the low-water protection from Station 63 + 33 to Station 68 + 93, and in filling the gap from Station 54 + 50 to Station 59 + 10. These piles were spaced 15 feet between centers, and were driven in a curve that would pass through the mattress near its outer edge. The mattress protection was 40 feet wide, and a single section covered each of the spaces in which piles were driven.

Medium stage protection.—The medium stage protection of riprap stone was extended 3,328 feet from Station 36 + 40 to Station 69 + 63, but was carried to the full height—16 feet above standard low water—only from Station 38 + 90 to Station 42 + 20, having been left at 11 feet between Station 42 + 20 and Station 51, and between Station 51 and Station 69 + 33, and Station 36 + 40 and Station 38 + 90, at 8 feet above the same plane. The elevations were determined by the stages of water which prevailed at the time the work was in progress; the revetment being in each case such small height above the surface of the water as could be conveniently reached from the stone barge. The average width of the medium stage revetment placed during the year was 31.5 feet, or a total of 104,540 square feet.

During the lower stages of the river, the medium stage protection, which was placed during the flood stages of the preceding year, was redistributed, making the thickness uniform over the whole surface. This work was done between Station 1 and Station 36.

Reference is made to Plate I for locations, and to the report of Mr. C. D. Lamb, submitted herewith, for further details.

The expenditures aggregated \$6,535 92, of which \$6,194.07 was charged to the appropriation for improving the channel opposite the city of Saint Louis; and \$341.85 to the general appropriation. The latter item was for labor.

HORSETAIL BAR.

Work was not entirely suspended at this locality during the prevalence of the flood stage, but the party of workmen was reduced to a single pile-driver crew, because all of the hurdle lines, except secondary No. 18, were submerged. This party worked on the repairs of No. 18, and made gates near the quarters on the west bank, for general use in repairs until the submerged lines were uncovered by the falling river about the last week of July. Additional working parties were then organized to resume the work of completing the repairs upon the primary line, which were under way when the flood came, to extend the line, to repair old and construct new secondary lines.

The lines from No. 18 to No. 30, inclusive, constructed during the years 1880 and 1881, had been injured by running ice during the winter, and by drift-wood during two flood seasons, to such an extent that they did not make an efficient obstruction to the flow of water, and a large body passed that way into the chute east of Carroll's Island at medium and high stages, with great velocity, preventing new and carrying away old deposits, threatening to reopen a passage that would deplete the navigable channel.

The plan adopted to make the obstruction efficient, included repairing and extending the primary line to connect with the bar on the head of Carroll's Island, at or above the stage of 16 feet above standard low water; repairing secondary lines Nos. 18, 23, 27, and 30, and constructing a line across the head of the chute.

Primary hurdles.—The east primary hurdle line was repaired from its head, near secondary No. 18, to its intersection with No. 30, in which 271 piles were driven, which is equivalent to the piling for 1,084 linear feet of hurdle; 750 linear feet of foundation mattress 50 feet wide, and 1,305 linear feet 30 feet wide, were constructed and placed; 2,512 linear feet of gates were placed, and 1,560 linear feet of fixed hurdles built. The width of the gates averages 18 feet, and the area equals 45,216 square feet. They were used above secondary line No. 25, and the length given includes all that were used between that point and the head of the primary line.

Fixed hurdles were used below secondary line No. 25. The length given completed the repairs to the lower end of the line, near its intersection with secondary No. 30. Of this, 200 linear feet between secondary lines Nos. 25 and 27 averaged 14 feet, and the remainder was 8 feet in width, making an area of 13,680 square feet.

Secondary hurdles.—Secondary hurdles were repaired. That of No. 18 was in progress July 1, and was continued until the 12th of August, when it was completed with the exception of bracing a small section in the gap near shore, which was done about the last of November. In these repairs 414 linear feet were rebuilt with piles, mattress, braces, and gates. Gates were placed 142 feet further, making 556 feet, and such piles as had become unserviceable upon 600 feet additional were replaced, making the pile-driving extend over 1,156 linear feet, and was equivalent to complete piling over 600 linear feet. The bracing extended over 1,090 linear feet, and the stringers over 1,240 linear feet.

The work on secondary line No. 23 consisted in driving 1,010 linear feet of piling, placing braces for 1,060 linear feet, hurdling 1,110 linear feet, and placing 150 linear feet of mattress. The hurdling averaged 15.5 feet in width, and was made by wadding the brush directly upon the piles.

On No. 27, 1,650 linear feet were reconstructed so far as relates to piling, hurdling, and bracing, and upon 382 linear feet of this length a mattress 30 feet wide was placed. Of the hurdles, 1,270 linear feet, having a width of 16.6 feet, were wattled, and 380 linear feet, of which the width was 19.5 feet, were curtain hurdles.

Work was begun on secondary line No. 30 November 23, and continued till the close of the season, December 6. About 1,200 linear feet of the line were reconstructed with piling, bracing, and stringers, 120 linear feet of foundation mattress constructed and sunk, and 1,760 linear feet of wattling placed.

Carroll's Island hurdle.—The construction of this line was begun on the 26th of March, and was continued until June 18, with the exception of about twelve days between May 22 and June 4, when the stage of the river was above the piling. The length of the line was determined when preparing to begin work and found to be 2,450 feet. The head of the island was afterwards eroded, which may extend it to 2,700 feet. Of this, however, nothing definite can be said, for deposits began to fill the space which had been eroded as soon as the river commenced falling—about the close of the year.

Piles were driven for the whole of the original length of the line; 2,350 linear feet of foundation mattress 46 feet wide were placed, extending up from the lower end of

the line, and the wattling was completed upon 1,625 linear feet, an average depth of about 11 feet.

Stringers were placed upon 2,092 feet of the drift row and 850 feet of the main row, and diagonal braces were placed 850 feet upon each of these two rows. Cross braces were placed for a distance of 437 linear feet from the island end.

Reference is made to Plate II for locations, and to the report of Mr. E. D. Libby, submitted herewith, for further details.

The expenditures aggregated \$51,473.93, distributed as shown in the accompanying statement:

STATEMENT OF EXPENDITURES AT HORSETAIL BAR FOR THE FISCAL YEAR ENDING
JUNE 30, 1883.

Primary hurdle:

Labor	\$2,932 52	
Piles	1,134 28	
Brush	2,102 63	
Stone	946 11	
Rope	200 09	
Wire	16 05	
Nails	16 80	
Spikes	30 08	
Lumber	407 66	
Bolts	1,020 82	
Subsistence	2,189 56	
Steamer Humphreys	112 40	
Pile-drivers	354 56	
Barges	6 24	
Quarters	119 70	
Small boats	83 00	
Tools and appliances	162 20	
		<hr/>
		\$11,834 70

Secondary hurdles:

Labor	4,515 15	
Piles	2,246 91	
Brush	1,716 67	
Stone	225 34	
Rope	210 43	
Wire	21 40	
Iron	4 54	
Nails	7 20	
Spikes	41 36	
Lumber	83 98	
Bolts	561 58	
Subsistence	2,496 24	
Steamer Humphreys	219 18	
Pile-drivers	859 52	
Quarters	228 90	
Small boats	96 28	
Tools and appliances	191 60	
		<hr/>
		13,726 29

Carroll's Island hurdle:

Labor	3,163 94	
Piles	3,360 02	
Brush	2,529 47	
Stone	720 00	
Rope	196 23	
Iron	2 60	
Wire	72 25	
Spikes	42 66	
Bolts	273 59	
Subsistence	2,552 41	
Steamer Humphreys	206 50	
Steamer Gillmore	200 00	
Launch Hornet	51 20	
Launch Florence	9 78	
Pile-drivers	1,043 01	
Barges	858 13	
Quarters	1,248 41	
Small boats	820 17	
Tools and appliances	1,090 88	
		<hr/>
		18,441 25

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Bank protection, head of Carroll's Island:

Labor	\$263 71
Piles	43 76
Brush	130 05
Stone	99 22
Rope	12 86
Wire	8 92
Nails	2 56
Spikes	5 56
Subsistence	166 64
Steamer Humphreys	16 52
Pile-drivers	44 03
Barge flats	63 96
Quarters	64 77
Small boats	41 44
Tools and appliances	54 88
	<hr/>
	\$1,018 88

Engineering and contingences:

Engineering	2,671 04
General expense	2,042 11
Telephone	313 48
Office furniture	12 17
Instruments	33 01
Boarding outfits	17 71
Contingencies	1,359 23
Surveys	4 06
	<hr/>
	6,452 81
	<hr/>
	51,473 93

TWIN HOLLOWES, WEST SIDE.

Work at this locality was in progress continuously from July 1 until the season was closed by the severe weather which followed the storm of December 6; resumed March 1, and continued to June 17, when the flood stage to which the river had risen prevented further active field operations. A small party was retained to care for property, including a crib which had been completed and was waiting for a favorable opportunity to be placed.

During the first half of the year the number of persons engaged was limited to that which could be profitably employed within the limits available for work without interfering with the navigable channel, which at the beginning of the year crossed the primary line about Station 90, and continued to the west shore; thence rebounding struck Beard's Island above Station 36; afterwards moving slowly down stream until at the end of November its line of greatest depth and velocity crossed the primary about Station 130; then swinging through a small arc, recrossed the line and continued to the foot of Beard's Island. To keep pace with this movement and leave the navigable channel free from obstructions, the rate of progress of the work was retarded through July, increased during August, and decreased again the 1st of September, after which it was continued slowly, keeping the head of the primary line in the margin of the channel, and building secondary lines fast enough to have each completed soon after the primary had reached the point of intersection.

The number of persons employed ranged between 100, July 1, and 300, September 1, then reduced to about 140, which number was employed until the end of the season, with the exception of a small reduction made after the middle of October by sending men to repair works at Pulltight.

During the second half of the year the amount of funds available confined operations to parts of works which were under process of construction and to repairs of lines which were damaged by ice at the breaking of the winter's gorges.

Primary hurdles.—The gaps in the primary line which existed at the close of the preceding year were closed and the line extended to Station 122+50. Of this distance piling was driven for 2,005 feet; foundation mattress, 50 feet wide, placed upon 4,075 feet, and 3,860 linear feet wattled an average depth of 13 feet.

The fixed hurdles closed the gaps below Station 6+20 and extended the line to Station 94, and from 104 to Station 122+50.

Willows.—The space between stations 94 and 104 was occupied by a high sand-bar, which was dry when the work in that vicinity was in progress. Willows were planted upon the upper half of it, and the balance was protected by a mattress.

Cribs.—In both primary and secondary lines cribs were substituted for piling where the earth on the bed-rock was not deep enough to hold piles.

Of these there were constructed and placed: In the primary line, 250 linear feet, above Station 6+20. In secondary No. 1, 270 linear feet; No. 2, 300 linear feet; No.

3, 175 linear feet; No. 4, 600 linear feet constructed, of which 410 feet were placed; No. 5, 300 linear feet.

Secondary hurdles.—Secondary hurdles Nos. 1 to 3, inclusive, were completed during the first half of the year. In Nos. 4 and 5 passage ways were left for an entrance to the sheltered basin of deep water found under No. 3, which had been selected for harboring the plant during the winter.

During the second half of the year work was carried on, which had for its object the completion of these lines and repair of the gaps made by the ice.

There were completed during the year: in line No. 1, piling and foundation mattresses each 570 feet, wattling 40 feet; No. 2, 270 feet of piling and foundation mattresses, 570 feet of wattling; No. 3, 1,020 linear feet of piling, 573 linear feet of mattress, and 605 linear feet of wattling; No. 4, 300 linear feet each of piling and mattress, and 840 feet of wattling; No. 5, 1,340 linear feet each of piling and mattress, and 1,640 linear feet of wattling.

The entire length of piling was braced. The width of the foundation mattresses averaged 30 feet, and the depth of wattling 13 feet.

Protecting deposits.—A low-water mattress having a width of 104 feet was constructed and placed just outside the primary line, extending from shore, near the origin of the line, to Station 16 + 45.

It was constructed during the fall season, and was designed to protect the deposits which had been secured.

Reference is made to Plate III for locations, and to the report of Mr. W. S. Mitchell, submitted herewith, for further details.

Expenditures aggregated \$93,136.91, distributed as shown in the accompanying statement:

STATEMENT OF EXPENDITURES AT TWIN HOLLOW, WEST SIDE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883.

Primary hurdles:

Labor.....	\$5,574 79
Piles.....	4,136 63
Brush.....	3,799 94
Stone.....	1,460 77
Rope.....	64 13
Wire.....	192 60
Nails.....	2 40
Spikes.....	53 48
Bolts.....	322 95
Subsistence.....	6,500 50
Steamer Humphreys.....	421 50
Launch Hornet.....	348 00
Pile-drivers.....	1,237 76
Barges.....	78 00
Quarter boats.....	133 95
Quarters.....	266 70
Small boats.....	209 62
Tools and appliances.....	412 05
	<hr/>
	\$25,215 77

Crib primary line:

Labor.....	1,150 44
Piles.....	422 50
Stone.....	474 48
Rope.....	16 24
Spikes.....	6 68
Bolts.....	181 01
Subsistence.....	664 00
	<hr/>
	\$2,915 35

Secondary hurdle:

Labor.....	5,965 87
Piles.....	4,200 76
Brush.....	3,331 96
Stone.....	308 40
Rope.....	22 66
Wire.....	274 32
Nails.....	19 49
Spikes.....	21 35
Bolts.....	464 83
Subsistence.....	5,700 53
Steamer Humphreys.....	393 40
Launch Hornet.....	344 83

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Pile-drivers	\$1,762 54
Barges	71 76
Barge flats	102 33
Quarter boats	128 25
Quarters	457 82
Small boats	409 62
Tools and appliances	912 05
	<hr/>

\$24,892 77

Crib secondary line :

Labor	5,263 78
Piles	2,495 14
Brush	214 57
Stone	855 03
Rope	79 34
Wire	15 27
Nails	10 48
Spikes	124 55
Bolts	776 23
Lumber	1,002 72
Subsistence	5,044 00
Miscellaneous supplies	36 87
Steamer Humphreys	132 16
Steamer Gillmore	200 00
Launch Florence	81 50
Pile-drivers	1,278 06
Barges	1,560 78
Barge flats	1,300 52
Quarter boats	91 28
Quarters	1,800 00
Small boats	672 48
Tools and appliances	968 04
	<hr/>

24,002 80

Low-water protection :

Labor	1,565 70
Piles	113 41
Brush	2,690 06
Stone	431 21
Rope	7 67
Wire	187 25
Nails	7 20
Spikes	48 88
Bolts	6 02
Subsistence	1,391 12
Steamer Humphreys	50 58
Steamer Hornet	46 40
Pile-drivers	49 28
Barge flats	303 65
Quarters	90 30
Small boats	69 88
Tools and appliances	137 34
	<hr/>

7,195 95

Engineering and contingencies :

Engineering	3,747 47
General expense	3,852 22
Telephone	677 95
Office furniture	26 50
Surveys	11 60
Instruments	67 84
Contingencies	530 69
	<hr/>

8,914 27

93,136 91

TWIN HOLLOW, EAST SIDE.

The work of protecting the bank at this locality was in progress at the beginning of the year, and was continued during the flood of July. The operations were confined to the fabrication of mattresses, until the river had subsided to stages suitable for placing the medium stage protection.

Low-water protection.—The section of low-water mattress which had been fabricated at the beginning of the year was extended to a length of 1,500 feet, and held until

the flood began to subside, when it was successfully placed. Another section 1,210 feet long was constructed and placed, which completed the low-water protection from Station 0 to Station 86.

Medium stage protection.—The zone between standard low water and 16 feet above that plane, was not in condition to receive complete revetment, the upper portion being too steep to retain stone. The protection was made continuous between Station 0 and Station 86, but its height was irregular, conforming to that of the slope suitable to receive it.

Of this protection, all except 200 feet between Stations 59 and 61 was placed during the fall season, and finished on the 19th of October. The bank upon the section between Stations 59 and 61 was vertical at the time the other work was done, and its protection was delayed so that it might be graded by the action of the river. This was done and the protection was placed here about the middle of May.

Reference is made to Plate IV for locations, and to the report of Mr. J. O. Holman, submitted herewith, for further details.

The expenditures aggregated \$23,232.31, distributed as shown in the accompanying statement:

STATEMENT OF EXPENDITURES AT TWIN HOLLOW, EAST BANK, FOR THE FISCAL YEAR ENDING JUNE 30, 1883.

Low-water protection:

Labor	\$3,249 99	
Piles	310 08	
Brush	3,023 51	
Stone	885 12	
Rope	325 75	
Wire	294 25	
Nails	43 20	
Spikes	75 20	
Subsistence	2,320 64	
Steamer Humphreys	134 50	
Pile-drivers	103 04	
Barges	184 08	
Barge flats	75 80	
Quarters	147 00	
Ways	162 00	
Small boats	75 70	
Tools and appliances	173 50	
		\$11,603 40

Grading:

Labor	165 99	
Subsistence	53 28	
Excavator	76 20	
		295 47

Medium stage protection:

Labor	1,087 36	
Piles	75 48	
Brush	1,199 90	
Stone	5,421 56	
Rope	7 67	
Wire	26 75	
Subsistence	1,875 87	
Steamer Humphreys	118 02	
Pile-drivers	42 24	
Quarters	69 33	
Quarter boats	28 50	
Small boats	37 85	
Tools and appliances	86 76	
		10,077 29

Engineering and contingencies:

Engineering	371 22	
General expense	701 16	
Telephone	103 83	
Survey	3 43	
Office furniture	3 97	
Instruments	10 42	
Contingencies	62 12	
		1,256 15
		23,232 31

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PULLTIGHT.

The work at this locality had for its object the closing of the small chute east of Beard's Island, and was begun soon after the 1st of July. It consisted of a line of primary hurdles, supported by secondary lines, and the protection of a portion of the head of the Willow Bar above Beard's Island.

Primary hurdle.—The primary line projected from the shore at Station 113 of the line of reference, which has its origin at the head of the revetment at Twin Hollows, east side, crossed to the deep water found near shore to a bar which was dry at a stage 16 feet above standard low water, upon a line located with special reference to economy in constructing and maintaining the works.

Piles had been driven and stringers placed to the bar, a distance of 2,860 feet from the shore, foundation mattresses placed upon 2,700 feet, bracing upon 2,425 feet, and wattling upon 1,100 feet of the line—measured in each case from shore. When work was suspended, June 8, on account of the high stage of the water, the average width of the mattress constructed was 40 feet, and the average depth of the wattling 15 feet. The location of this hurdle below its intersection with the bar has not been definitely determined, but will be upon the most direct and economical line to the head of the Willow Bar previously mentioned.

Secondary hurdles.—No. 3 was constructed across the head of the chute during July and August, at a distance of about 4,200 feet from the origin of the primary line. This hurdle was about 850 feet long and averaged 10 feet in depth, having an area of 8,500 square feet.

Line No. 1 was extended 200 feet from shore; only the piling was driven.

Bank protection.—Two mattresses were constructed during the month of May to protect the bank just above and below the shore end of the primary hurdle line. The former of these was 290 feet long by 45 feet wide, and the latter 145 feet by 25 feet.

Another mattress was commenced in June to protect the head of the Willow Bar above Beard's Island, a section 100 feet long by 58 feet wide has been constructed and placed at the time operations were suspended in that month.

Reference is made to Plate III for locations, and to the report of Mr. J. O. Holman, submitted herewith, for further details.

The expenditures aggregated \$46,465.47, distributed as shown in the accompanying statement:

STATEMENT OF EXPENDITURES AT PULLTIGHT FOR FISCAL YEAR ENDING JUNE 30, 1883.

Primary hurdle:

Labor.....	\$6,217 64
Pile timber.....	6,595 96
Brush.....	5,798 03
Stone.....	1,886 48
Rope.....	147 11
Wire.....	140 46
Nails.....	13 41
Spikes.....	74 00
Bolts.....	472 68
Iron.....	43
Subsistence.....	5,032 61
Steamer Humphreys.....	371 52
Steamer Gillmore.....	210 00
Launch Hornet.....	69 60
Launch Florence.....	716 23
Pile-drivers.....	1,773 21
Quarters.....	1,747 27
Barge flats.....	959 40
Skins.....	650 60
Tools, &c.....	1,066 30
	<hr/> \$33,941 94

Secondary hurdle:

Labor.....	2,217 19
Pile timber.....	1,060 44
Brush.....	1,088 83
Stone.....	303 05
Rope.....	23 01
Wire.....	37 45

Nails	\$1 20
Spikes	11 28
Bolts	24 08
Subsistence	1, 220 27
Steamer Humphreys	106 44
Steamer Gillmore	50 00
Launch Florence	13 04
Barge flats	53 30
Pile-drivers	325 11
Quarters	100 86
Skiffs	43 91
Tools	86 76
	<hr/>
	\$6, 766 22

Engineering and contingencies:

Engineering	2, 542 39
General expense	1, 868 72
Surveys	2 95
Telephone	377 04
Office furniture	18 16
Instruments	46 72
Contingencies	901 33
	<hr/>
	5, 757 31
	<hr/>
	46, 465 47

BEARD'S ISLAND.

Low-water protection.—In continuation of the revetment of the west bank of this island 4,850 linear feet of low-water mattress of the standard width of 120 feet, and 335 linear feet, 100 feet wide, were constructed. Of the standard width mattress only about 3,600 linear feet was successfully placed, protecting 3,500 linear feet of bank, between Stations 35 + 50 and 70 + 50. The difficulties encountered between Stations 35 + 50 and 49 + 75 were excessive, being made so by the peculiar configuration of the water-way and bars in the vicinity. The channel was in a state of transition, and the axis of greatest velocity, crossed from the bluffs at the beginning of July, as shown in the map of the locality, plate V, striking the bank at Station 36, the point at which the low-water mattress was then under process of construction. The lower reef projecting from the Missouri shore threw nearly the whole volume of the river against the island through a funnel-shaped stream, of which the lower orifice was not more than 350 feet wide during a period of several days with the river about 6 feet above standard low water.

The point of impact moved continuously down stream at about the same rate that the construction of the low-water mattress progressed, keeping the force which opposed the construction and sinking of the mattress at a maximum.

The slow progress made in completing the low-water protection may be traced in part to the deep, swift water crossing the line under an obtuse angle, and in part to the drift-wood brought in contact with the mattress during the flood of July.

Medium stage protection.—Medium stage protection was extended from Station 16 + 50 to Station 18, and from Station 28 to 65, except a section 50 feet long below Station 35, and another 300 feet in length between Stations 59 and 62, by a revetment of riprap stone. The total length thus protected was 3,500 feet, and of this amount 850 feet between Stations 16 + 50 and 18, Stations 28 and 33, and from 40 + 50 to Station 42 + 50 was carried to the required height—16 feet above standard low water—and the remainder was only carried to 6 feet above that plane.

A medium-stage mattress 600 feet long by 60 feet wide was placed between Stations 44 and 50, and another 900 feet long and averaging 80 feet in width between Stations 64 and 73. The latter was supplemented by the 100-foot wide mattress previously mentioned.

Grading.—Grading by the hydraulic excavator was begun below Station 35 and carried a distance of 1,043 feet. Its object was to reduce a steep bank varying from 14 to 20 feet in height to a uniform grade of 2 to 1, to facilitate the placing of riprap protection.

This class of work was carried on less than a month, but the results were satisfactory.

Reference is made to Plate V for locations, and to the report of Mr. J. E. Savage, submitted herewith, for further details.

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The expenditure aggregated \$55,810.47, distributed as shown in the accompanying statement:

STATEMENT OF EXPENDITURES AT BEARD'S ISLAND FOR THE FISCAL YEAR ENDING JUNE 30, 1883.

Low-water protection:

Labor	\$9,479 41	
Piles	1,391 25	
Brush	13,993 48	
Stone	2,093 71	
Rope	70 70	
Wire	497 55	
Iron	9 08	
Nails	19 20	
Spikes	56 40	
Bolts	34 40	
Subsistence	8,409 68	
Steamer Humphreys	826 14	
Steamer Anita	32 12	
Launch Florence	35 72	
Pile-drivers	438 40	
Barges	399 36	
Barge flats	132 20	
Quarters	548 10	
Ways	502 65	
Small boats	327 64	
Tools and appliances	654 39	
		<hr/>
		\$39,951 58

Grading:

Labor	389 40	
Subsistence	370 36	
Excavator	380 41	
Small boats	14 00	
Tools and appliances	28 00	
		<hr/>
		1,182 17

Medium stage protection:

Labor	2,297 90	
Piles	477 22	
Stone	3,828 22	
Rope	120 06	
Spikes	48 88	
Subsistence	2,026 60	
Steamer Humphreys	230 42	
Launch Florence	9 40	
Quarter-boats	42 75	
Quarters	50 40	
Small boats	78 12	
Tools and appliances	156 23	
		<hr/>
		9,366 20

Engineering and contingencies:

Engineering	1,328 00	
General expense	2,055 09	
Telephone	306 24	
Surveys	9 86	
Office furniture	11 47	
Instruments	25 34	
Contingencies	1,574 52	
		<hr/>
		5,310 52
		<hr/>
		55,810 47

CHESLEY ISLAND.

Low-water protection.—The revetment of this island was begun about the 20th of September and continued until the 5th of December, when 4,464 linear feet of bank between Stations 0, and 44+64 had been protected by placing a mattress 120 feet wide with its inside edge as nearly as practicable in the curve of standard low water. Of this, 4,305 linear feet were constructed and placed in a single section in water varying from 24 to 30 feet in depth, and flowing swiftly, say with a surface velocity of 5 feet per second. This section could have been continued an indefinite length, and was terminated by the completion of the work to the point at which the channel leaves the high ground of the island.

The remaining 164 feet were protected by a section recovered from a wreck of one of the mattresses at Beard's Island, which was landed here by the steamer Humphreys and was afterwards floated to lower end of this protection and placed as a part of it.

This becomes the longest section of mattress in the world. It was constructed and placed with only a single small break which occurred about Station 20, but did not destroy the efficiency of the protection even upon the space that it occupied.

The entire section of 4,305 linear feet was constructed in fifty-six working days, of which thirty were reckoned at ten hours and the remainder at nine hours, but upon twenty of these days the party consisted of not more than twenty workmen, or less than one-third of a full force. The exact time spent upon the mattress was 28,015 hours; calling sixty laborers a full party this would be equivalent to forty-seven working days of ten hours each, and would make the daily average 94 feet. This rate was exceeded upon several days, and could be maintained indefinitely where the difficulties were not excessive if the party could be kept full. This seems impracticable, however, except by having a reserve from which the party can be filled at pleasure; and this can be done only when other works are in progress under the same supervision.

Medium stage protection.—Extending the protection up to the plane of 6 feet above standard low water followed the placing of the low water mattress closely, leaving only room enough between for movements of barges used in connection with the work.

It reached Station 39 at the close of the fall season, and during the second half of the year it was raised to 16 feet above standard low water to a distance of 3,475 feet below Station 0, at the head of the island.

Protection of the head of the island.—The protection was extended around the head of, and upon the opposite side of the island to Station 5+85, measured from the zero station of the original line. The mattress for this protection was an average of 40 feet in width, and the riprap protection extended to 14 feet above standard low water.

A medium stage mattress about 400 feet long by 50 feet wide was built and placed as an additional protection to the head of the island and to prevent the undermining of the upper end of the low-water mattress. It extends up-stream from the head of the latter.

Grading.—Grading by the hydraulic excavator was completed from the head of the island—Station 0 to Station 27+60.

The bank was about 18 feet above the water's surface at 6 feet above standard low water, and was excavated to a slope of 2 to 1, which gives about 12 cubic yards per linear foot, or about 33,000 cubic yards excavated in all.

Hurdles.—A hurdle line about 900 feet long to cross the chute west of the island was commenced April 18, and work continued on it until operations were stopped by high water June 15. Its location was about 700 feet below the mouth of Meramec River and 1,000 feet below the head of the island.

Piles were driven for 800 feet of the line, leaving a gap of about 100 feet near the middle. Of this, 720 linear feet was furnished with foundation mattress, and 250 feet with longitudinal stringers.

Reference is made to Plates III and VI for locations, and to the report of Mr. C. V. Mersereau, submitted herewith, for further details.

The expenditures aggregated \$47,401.39, distributed as shown in the accompanying statement:

STATEMENT OF EXPENDITURES AT CHESLEY ISLAND FOR THE FISCAL YEAR ENDING JUNE 30, 1883.

Low-water protection:

Labor	\$4,278 59
Piles	930 63
Brush	8,946 93
Stone	1,419 25
Rope	120 73
Wire	387 72
Nails	19 36
Spikes	210 47
Subsistence	3,763 44
Steamer Humphreys	202 32
Steamer Anita	8 03
Pile-drivers	298 41
Barges	246 48
Quarters	563 45
Ways	280 28
Small boats	147 31
Tools and appliances	373 01
	<hr/> \$22,196 41

1204 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Grading:	
Labor	\$294 03
Subsistence.....	189 86
Excavator	375 92
	<hr/>
	\$859 81
Medium stage protection:	
Labor	691 32
Piles	38 10
Brush	467 25
Stone	8,027 70
Rope	5 30
Wire	21 40
Subsistence	1,338 15
Steamer Humphreys	67 44
Pile-drivers	82 56
Quarters	488 35
Small boats	69 37
Tools and appliances.....	330 21
	<hr/>
	11,627 15
Hurdle:	
Labor	1,239 94
Piles.....	1,324 02
Brush.....	887 50
Stone	600 27
Rope	19 25
Wire	17 84
Nails	2 56
Spikes.....	16 70
Bolts	6 25
Subsistence	1,242 28
Steamer Humphreys.....	16 52
Steamer Gillmore.....	120 00
Pile-drivers.....	628 32
Quarters	759 46
Small boats	133 64
Tools and appliances.....	740 88
	<hr/>
	7,755 43
Engineering and contingencies:	
Engineering	1,766 74
General expense	1,481 98
Telephone	526 88
Survey	3 48
Office furniture	20 66
Instruments	53 02
Contingencies	1,109 83
	<hr/>
	4,962 59
	<hr/>
	47,401 39

JIM SMITH'S

The work of construction at this place was suspended, on account of high water from the 1st to the 17th of July, when it was resumed upon the primary line at Station 9 on the branch from F to F, and continued to the close of the working season, December 6, since which time no work of construction has been done.

Primary hurdle.—The primary hurdle was under process of construction from the date of resumption until the close of the fall season, and during that time was extended from Station 9 to Station 34 on the branch F F, and in addition piles were driven to Station 35+50.

The branch F E was completed from Station 53 to 77 and in addition piles were driven from Station 41 to 53, and from Station 77 to 86+50. Foundation mattress was constructed and placed for 5,800 feet between Stations 9 and 35 on the branch F F, and between Stations 50 and 82, on the main line from F to E. Braeing was placed on 6,420 feet, and stringers on 1,010 additional feet, or a total length of 7,430 feet. The average depth of wattling was 22 feet, making 107,800 square feet.

Late in the season the water which found an outlet east of the large middle bar lying upon both sides of the primary line, concentrated into a narrow passage, swept the inclined branch from Station 10, cut the bar away to F, and damaged the line to the extent of scouring out piles upon 150 feet of its length from Station 34 to 35+50

and eroded to dangerous depths upon the entire distance. These breaks were rebuilt, a mattress was placed to prevent the erosion of the bar in the vicinity of F, and another was begun about Station 14 on the branch line F F but was suspended when only 150 feet had been built.

Willows.—Willows were planted in four rows and cottonwood in one, from Station 0 on the main line to Station 33 upon a bar which became dry throughout its entire length at 10 feet above standard low water, and of which the highest point was uncovered when the declining river reached 13.5 feet above that plane.

Secondary hurdles.—Secondary hurdles were under process of construction from the day on which they were commenced in July to the close of the fall season with the following results:

Line No. 1, which was begun in July, was completed with piling, bracing, stringers, mattress, and wattling. Its length was 870 feet.

Line No. 2 was completed from shore to a distance of 1,890 feet, and of these were duplicated 500 feet of piling, 450 feet of mattress, and 450 feet of stringers, in repairing breaches.

Line No. 3, was completed as follows: Piles were driven, and stringers, braces, and mattress placed for 1,445 feet, of which 1,195 feet were wattled.

Line No. 4 was completed to a distance of 575 feet from shore.

Line No. 5 was completed. Its length was 1,050 feet.

Line No. 6 was completed to a distance of 750 feet from the primary line, whence a bar, dry at medium stages, extended to the high bank.

Summing up the work done upon secondary lines Nos. 1 to 6, inclusive, their results: Piles driven for 7,600 feet; mattress and stringers, each placed upon 7,550 feet; braces upon 6,520 feet of line, and 6,330 feet were wattled.

Reference is made to Plate III for locations, and to the report of Mr. J. O. Holman, submitted herewith for further details.

The expenditures aggregated \$103,418.37, distributed as shown in the accompanying statement:

STATEMENT OF EXPENDITURES AT JIM SMITH'S FOR THE FISCAL YEAR ENDING JUNE 30, 1883.

Primary hurdle:

Labor	\$13,861 63
Piles	7,786 72
Brush	7,415 66
Stone	2,262 52
Rope	755 45
Wire	283 55
Iron	27 24
Nails	16 80
Spikes	131 60
Lumber	85 92
Bolts	1,218 62
Subsistence	13,493 76
Steamer Humphreys	393 40
Steamer Anita	136 51
Launch Florence	317 72
Pile-drivers	2,053 24
Barge flats	83 38
Quarters	826 33
Quarter boats	25 65
Small boats	421 08
Tools and appliances	815 20
	<hr/>
	\$52,416 98

Secondary hurdle:

Labor	10,943 76
Piles	7,677 30
Brush	4,307 92
Rope	333 45
Wire	171 20
Stone	1,497 30
Iron	18 16
Nails	9 60
Spikes	86 48
Lumber	95 92
Bolts	1,269 36
Subsistence	10,401 09

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Steamer Humphreys	\$309 10
Launch Florence.....	167 32
Pile-drivers.....	2, 094 15
Quarters.....	644 70
Quarter boats.....	22 85
Small boats.....	315 81
Tools and appliances.....	611 43
	<hr/> \$40, 976 90

Engineering and contingencies:

Engineering.....	1, 777 50
Contingencies.....	4, 239 97
General expense.....	3, 408 45
Surveys.....	16 48
Telephone.....	511 46
Office furniture.....	19 59
Instruments.....	51 04
	<hr/> 10, 024 49

103, 418 37

SUPPLY DEPOT.

Depot fenced.—A board fence was constructed to separate the depot yard from the thoroughfare for footmen, along the line of Iron Mountain and Southern Railroad. The fence covered the whole front, 900 feet in length, but by connecting the outside walls of the store-rooms and other permanent buildings the length necessary to be constructed was reduced to 521 feet. The expenditures on account of labor and materials for this fence, which are the only expenditures chargeable to the supply depot, were, for labor, \$76.18; for material, \$84.16.

Additions to plant.—The plant was increased by adding one tow-boat, General Gillmore; three barge-flats, Nos. 57, 58, and 59; seventy-six sections of portable shanties for mess-rooms, kitchens, quarters, and store-rooms; four small portable shanties, one wharf-boat, one floating machine shop, and nineteen hurdling flats. Of these the *General Gillmore* was built on the Ohio River; and had only the fitting for an electric light and other minor work done at the depot. The barge flats were coal barges which were purchased and altered to make them suitable for the transportation of material on deck. The sections of portable shanties for quarters, small shanties, and hurdling flats were constructed at the depot from material purchased. The machine shop and wharf-boat were built at the depot upon hulls of pile-drivers which had become unserviceable for driving piles.

Extraordinary repairs.—The following-named vessels received considerable repairs: Tow-boat A. A. Humphreys, launches Florence and Hornet, pile-drivers Nos. 3 and 5, barges 12 and 23, and barge flats Nos. 32, 49, and 51.

Ordinary repairs.—The following received ordinary repairs: Barges Nos. 9, 10, 13, 14, 16, 17, 20, 22, 25, 26, and 27; barge-flats Nos. 28, 33, 34, 38, 40, 42, 54, 57, 58, and 59; mat-tress-barge No. 3; quarter-boats Nos. 2, 4, and 6; the wharf-boat and small boats.

Material.—All of the smaller material, such as rope, iron, wire, nails, and spikes and the miscellaneous material used in the different works were stored at the supply depot and issued as needed. In addition to handling and shipping this material, 20,845 bolts were constructed of assorted sizes for use at the localities where work of improvement is being carried on.

Reference is made to the report of Mr. C. L. Stevenson, submitted herewith for further details.

PROCURING MATERIALS.

During the first half of the year each class of material was procured as in the pre-ceding year. Piles, stone, rope, wire, iron, nails, and spikes, were procured by purchase in open market. The piles were usually delivered at the works in rafts, but occa-sionally on barges; the cost of delivery being included in the price paid. Stone was delivered on barges belonging to the United States at quarries operated by the per-sons who furnished it. Rope, wire, iron, nails, and spikes were purchased in open market and delivered to the supply depot.

During the second half of the year the purchase in open market yielded to contracts the delivery of each class remaining as before.

Brush continued to be procured by hired labor and purchase of royalty.

All the works were supplied from a common stock. The quantity of each class ex-pended and on hand is shown in the appended table.

Statement showing quantities of material expended during the fiscal year ending June 30, 1883, and on hand at its close.

Kind.	Expended.	On hand June 30, 1883.
Piles, assorted sizes.....number..	19,625	3,809
Brush.....cords.....	26,065.1	931.8
Stone.....cubic yards.....	38,796.3	1,296.9
Rope, sisal, assorted sizes.....pounds.....	32,739	42,234
Wire, assorted sizes.....do.....	54,006	66,395
Iron, assorted sizes.....do.....	68,402	56,449
Nails, assorted sizes.....do.....	17,078	17,023
Spikes, assorted sizes.....do.....	34,240	35,763
Boils, assorted sizes.....do.....	12,435	3,071
Lumber.....feet.....	472,603	79,284

PLANT.

The plant available for use in connection with the works in this vicinity was freely transferred between localities as needed. It was increased during the year by the addition of one tow-boat, seven model barges, ten barge flats, three pile-drivers, twenty-six buildings for portable quarters, forty-one small boats, and tools and appliances. Of these three barge flats were converted from coal flats which were purchased, and nineteen small flats and twenty-two portable buildings were built from material purchased.

The others were returned from works carried on in the vicinity of Cape Girardeau and at Alton Harbor, and of these the Anita was dismantled and her machinery used in the construction of the new tow-boat General Gillmore.

The plant thus increased and concentrated is adapted to the employment of two thousand laborers and to the expenditure of \$1,000,000 per annum.

INFLUENCES OF RIVER STAGES AND WEATHER.

Prevailing stages.—The river remained below the stage of 14 feet above standard low water from July 30 until field operations were suspended on account of severe weather on December 6.

During the second half of the year it was above that stage from the middle of February until the end of June, with the exception of the twenty-six days ending April 22.

Considering the cost per unit of measure, the low stages prevailing during the first half of the year were more favorable for the construction of hurdles, but the value of the hurdles should be based upon the results they secured by inducing deposits within the areas which are to be reclaimed by them, and considered in this connection the hurdles built during the high stages are the most economical.

Flood stages.—The year opened and closed with the river in flood, and another remarkable one occurred about the middle of February, when the ice gorges above were broken up by a rise of 20.5 feet between the 13th and 18th. Of this rise 9.8 feet occurred within the twenty-four hours ending at 1 o'clock p. m. on the 16th.

The flood, which had about reached its height at the beginning of the year, caused considerable damage to the hurdles at Horsetail and Twin Hollows, west side. Only 900 feet of primary hurdle had been constructed at Jim Smith's, and this sustained only slight damage. At Twin Hollows, east side, and Beard's Island, where bank protection was in progress, the only injuries sustained were to mattresses which were under process of fabrication. The completion of mattresses was delayed at both localities; a part of the one at Twin Hollows was driven ashore by the accumulation of drift-wood, while the one at Beard's Island was finally lost by the parting of its mooring lines.

Upon the decline of the flood heavy deposits were made in areas inclosed by hurdles at each of the localities.

At Jim Smith's the channel, which had been divided into several branches, each of which had small depth, was concentrated into a single stream deep enough for the largest vessels that were engaged in navigating the river.

The height to which the river attained in February—22 feet above standard low water—would scarcely entitle that rise to be classed among floods, but the ice borne by its swift currents from the gorges which had broken in the Missouri River damaged river works and crafts more than the drift-wood which accompanied the other floods, and that fact places it in the rank of floods, when considered as a destructive agent. The contraction works at Horsetail, Twin Hollows, and Jim Smith's were seriously injured by the ice driven by the excessive currents of this flood, the extent of which has not been definitely ascertained, on account of the continuous high water

since that date. The facts, as far as known, are stated in the reports of resident engineers stationed at these localities.

At Twin Hollows, west side, the cribs in secondary lines Nos. 4 and 5 were moved out of place by the ice, which was formed during the winter in the inclosed spaces above them, and which went out in large fields when the flood was about its extreme height. Of the hurdles reported lost at the different works a portion of them are probably serviceable at lower elevations, having been mashed down by the weight of ice.

Large deposits were secured in the inclosed spaces.

The flood of June reached its summit on the 25th of the month, and its deposits within the areas inclosed by hurdles were made too late to be shown on the plates which accompany these reports.

An examination made from the pilot-house discovered that very satisfactory changes had been induced by the works during the first ten days of the flood's decline, which were shown in the large deposits made within inclosures, and in the concentration of the navigable channel into a single stream having abundant width and depth, and the changes in direction are by such easy curves that it can be run by the largest tow-boats upon the river, with fleets of barges, under full head of steam.

Weather.—During the first half of the year the weather was favorable for field operations up to December 6, when a severe storm set in of wind, accompanied by rain at first, which was soon replaced by snow. The temperature fell rapidly, reaching 19 degrees below zero within twelve hours after it began. This storm set in during the afternoon, and on the following morning the river was so full of sharp, thin ice that boats, barges, and other vessels appertaining to the plant could not be safely left in exposed situations, and in consequence they were harbored, some temporarily at the localities at which they happened to be, and others were sent to the winter harbor, which had been selected at Twin Hollows. The high stage of the river prevented the formation of gorges at once, and an opportunity was thus afforded to transfer all of the plant to the winter harbor within a few days, except two pile-drivers, which were left at Beard's Island and Jim Smith's, respectively.

High winds prevailed during the greater part of the working season of the second half year, which retarded the progress of constructing hurdles.

Rafts of piles were delayed en route, which at times caused suspension of work for lack of material. On some days the pile-drivers could not be operated with safety in the high waves which occurred more frequently than usual on account of high upstream winds that met the unsheltered current of a high river. Of the whole time from March 1 to June 30 not less than one-half was unfavorable for making the movements of vessels and pile-rafts needed in the prosecution of the work.

CARE OF EMPLOYÉS.

Quarters and subsistence.—Persons employed upon the works away from the city were furnished with quarters and subsistence by the United States, as in the preceding year, with satisfactory results.

Sanitary measures.—After the subsidence of the summer flood, malarial diseases became so prevalent that the working parties could not be kept full, although the number of applicants was far in excess of the ordinary demand, and men were received upon the works daily. A few days' exposure to the influence of the malaria of the bottoms seemed sufficient to prostrate the stoutest men with intermittent fevers or with chills. To counteract these malarial influences in part at least, fires were lighted in the quarters an hour before breakfast every morning and after dark, and a wine-glass of a mixture of cinchona bark and whisky was given to each employé who was subsisted by the United States, during the sickly season.

COMMUNICATIONS.

Telephone.—The supply depot and the offices of resident engineers located upon the west bank of the river have been in direct communication with the Saint Louis office and with each other by the telephone line which at the beginning of the year was in operation from the main office to the mouth of the Meramec River, with intermediate stations at Supply Depot, Horsetail Bar, and Twin Hollows.

An intermediate station was established at White House, opposite Beard's Island, and the line was extended to Bushberg, opposite Foster's Island, during the year.

Some annoyance was experienced by interruptions in the working of this long line, which, in a majority of cases, could be traced to electrical disturbances, which prevented the ringing of the call-bells, and this was partially overcome by placing a list-ener at each instrument at stated hours.

Other means.—The available means of communication other than by telephone were: By mail from Jefferson Barracks and Kimswick, Mo., and Meramec Point, Ill.; by telegraph from Jefferson Barracks and Kimswick, and by the steamers and small boats of the plant, as in the preceding year.

STABILITY OF THE WORKS.

Bank protection.—The works which have protection of banks for their object have been severely tested at the several localities where they have been applied, and have not yet failed to afford efficient protection and to arrest the most obstinate and active erosion at once. Difficulties have been encountered in placing mattresses for low-water protection in deep, swift water, flowing in whirls or crossing the line of works obliquely, which have in some cases been so excessive that losses have occurred during the process. The protection has been perfect, however, from the instant the mattress was placed, in every case.

Contraction works.—Works which have for their object the reclamation of land from the river are necessarily exposed to the action of the current, at times loaded with ice and drift-wood through longer periods, and have sustained more or less damage during floods and in breaking of ice gorges formed during the winter.

They have frequently, however, accomplished the object for which they were built, by inducing deposits after they had been torn out of place, broken down, or turned over, showing that they were efficient, though not strong enough to resist the pressure to which they may be subjected by accumulations of ice and drift-wood.

II.—IMPROVING THE CHANNEL OF THE MISSISSIPPI RIVER OPPOSITE THE CITY OF SAINT LOUIS, MISSOURI.

The works under the above heading have for their object, first, the closing of Cahokia chute; second, protecting the west bank of Arsenal Island.

Mr. C. D. Lamb, resident engineer, was charged with the immediate supervision of these works during the last half of the year.

CAHOKIA CHUTE.

Cahokia Dam.—The dam constructed across this chute during the fiscal year ending June 30, 1879, had not only diverted the navigable channel from the east side of Arsenal Island, but had closed the chute at low stages of the river.

The crest of the dam, which was originally five feet above standard low water, was found when work was begun in March of this year at about 2 feet above that plane.

Hurdles constructed.—The work done during the present year had for its object the closing of the chute at medium stages of the river, and the plan adopted included the construction of hurdles across it, above the dam, and two lines have been so constructed.

On account of their exposure to drift-wood these hurdles were built and braced after the forms used in primary lines.

Line No. 1, located 80 feet above the center of the dam and parallel with it, was begun March 17, and completed April 7. The river rose very rapidly about the 23d of April, and reached a stage of 16 feet above standard low water, and the pressure severely tested the strength of the new line. A breach 50 feet wide was made about 400 feet from the Illinois shore, and the piling upon a section of the same length adjoining the island was pressed out of vertical position.

Prompt action restored the efficiency of the line before further damage was done. This line is 1,800 feet long; the average depth of hurdle is 13 feet, giving an area of 23,400 square feet. The foundation mattress extends over the entire length, is about 62 feet wide, with an area of 112,200 square feet.

Line No. 2, located 1,100 feet above No. 1 at the island, and 2,100 feet above it at the other end, was begun April 2, and continued until the 17th of May, when the submergence of the piles caused a suspension. After this continued high water prevented permanent resumption.

An attempt to continue work was checked by another rise June 5.

The length of the line is 2,500 feet, of which 1,300 feet are completed, and the remaining 1,200 feet lacks only the wattling for completion.

Results.—The time that elapsed after the hurdles became efficient in inducing deposits was too short to secure large results during the fiscal year. Within that period there were only a few days upon which deposits would probably be secured, and these were during the last week of the year, after the flood began to subside, while the river, heavily laden with sediment, was falling at the rate of one to one and one-half feet per day.

Soundings taken July 2, 1883, show that during the preceding month a deposit to the depth of 7 feet upon the average was made over the whole area comprised in the part of the chute which lies above hurdle No. 1.

1210 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Reference is made to Plate I for locations, and to the report of Mr. C. D. Lamb submitted herewith, for further details.

The expenditures aggregated \$40,873.88, distributed as shown in the accompanying statement.

STATEMENT OF EXPENDITURES AT CAHOKIA CHUTE FOR THE FISCAL YEAR ENDING JUNE 30, 1883.

Hurdles Nos. 1 and 2:

Labor	\$8,915 57	
Piles	6,694 93	
Brush	6,322 71	
Stone	1,672 99	
Rope	97 70	
Wire	75 23	
Iron	21 09	
Nails	2 56	
Spikes	55 65	
Bolts	697 18	
Subsistence	4,265 56	
		\$28,821 17
Steamer Humphreys	421 26	
Steamer Gillmore	130 00	
Launch Hornet	436 94	
Pile-drivers	2,412 13	
Barges	20 01	
Barge flats	959 40	
Quarter-boats	296 66	
Quarters	1,061 72	
Small boats	1,022 00	
Tools and appliances	1,179 92	
		7,940 04

Engineering and contingencies:

Engineering	1,025 13	
General expense	2,108 09	
Telephone	575 16	
Office furniture	23 72	
Instruments	55 53	
Contingencies	325 04	
		4,112 67
		40,873 88

ARSENAL ISLAND.

A full account of the operations at this locality may be found in Part I, and in the accompanying report of Mr. C. D. Lamb.

The expenditures which were charged to the special appropriation for improving the channel of the Mississippi River opposite Saint Louis, Mo., aggregated \$6,194.07, distributed as shown in the accompanying statement.

STATEMENT OF EXPENDITURES AT ARSENAL ISLAND FOR THE FISCAL YEAR ENDING JUNE 30, 1883.

Low-water protection:

Labor	\$487 96	
Piles	147 74	
Brush	760 95	
Stone	229 14	
Rope	61 36	
Wire	26 75	
Spikes	15 04	
Steamer Humphreys	28 10	
Pile-drivers	46 08	
Small boats	44 88	
Tools and appliances	88 86	
		\$1,936 86

Medium stage protection:

Labor	\$1,007 55	
Stone	2,860 07	
		<u>\$3,867 62</u>

Engineering and contingencies:

Engineering	2 85	
General expense	220 94	
Telephone	33 44	
Office furniture	92	
Instruments	2 76	
Contingencies	128 68	
		<u>389 50</u>
		<u>6,194 07</u>

2.

ARSENAL ISLAND.

REPORT OF MR. C. D. LAMB, ASSISTANT ENGINEER.

ARSENAL ISLAND, July 1, 1883.

MAJOR: I have the honor to submit the following report of operations at Arsenal Island during the fiscal year ending June 30, 1883:

The portion of this report referring to the work done during the fall of 1882 is the substance of the report made by Mr. A. F. Freis, resident engineer, who was in local charge at that time.

The work done during the past year is located, as shown on the accompanying tracing, Plate I, by numbered stations 100 feet apart extending down-stream from the 0 station, which is at the intersection of the line of Cahokia Dam with the west bank of the island.

Work was resumed at this place August 16, 1882, when the high water which caused the suspension of operations June 30 had subsided to such a stage that work could be carried on to advantage. The guide piles carried away by high water between Stations 54 + 50 and 59 + 10 were replaced, and the line was then extended from Station 63 + 33 to the foot of the high bank at Station 68 + 93. These piles were driven 15 feet apart as heretofore, and at such distances from the shore as would allow the inner edge of the mattress to extend up to the plane of standard low water after being sunk. Meanwhile a small force of men had, since the latter part of July, been engaged in cutting brush upon the island and bringing it to the bank. This force began the construction of a low-water mattress August 25. A section 460 feet long was built and placed to close a gap between Stations 54 + 50 and 59 + 10. The remainder of the mattress built during the half year was used to extend the low-water protection from Station 63 + 33 to the lower end of the high bank at Station 68 + 93.

This mattress, 40 feet wide, was built, as during the previous season, inside the line of guide piles which supported its outer edge while its inner edge rested upon flats. It was composed of two layers of brush crossing each other at right angles and held between grillage poles placed at intervals of 6 feet.

The force was reduced September 14, and employed until the 25th in re-distributing the stone placed between Stations 1 and 36 in the mean stage revetment during the high water of the previous half year.

A supply of stone having been secured, the construction of medium stage revetment was begun at Station 38 + 90. This protection was carried to a height of 16 feet above standard low water to Station 42 + 20. It was raised to 11½ feet above the same plane from Station 42 + 20 to Station 51, but from that point to Station 69 + 68 as well as between Stations 36 + 40 and 38 + 90, it was left at 8 feet above standard low water.

The average width of the revetment built during the year was 31.5 feet and covering a surface of 104,540 square feet.

Nothing was done at this place during the last half year. The revetment could not be thoroughly inspected during the spring on account of the prevailing high stage of river, but as far as could be observed the work has not deteriorated since construction, although the bank above the medium stage revetment has been cut back for several feet by the strong currents prevailing during high water.

The hurdle built between Stations 36 and 39 to fill out the bank to the proposed shore-line is slowly accomplishing the desired result. Its outer end, however, has been cut down by ice and drift, and its efficiency would be increased by repairs.

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The following statement shows the number of linear and square feet of mattress and revetment built during the year, with the cost of the labor and material used in its construction.

For low-water protection:

To labor, constructing 1,003 linear feet, 40 feet wide, or 240,120 square feet of mattress	\$667 45	
To labor, sinking mattress	60 50	
		\$727 95
To labor, driving piles	101 86	
To pile timber, 65 sticks, 2,661 feet driven	147 74	
		249 60
To brush, 265 cords		760 95
To stone, 241½ cubic yards		229 14
To rope, 785 pounds		61 36
To wire, No. 12, 350 pounds		26 75
To spikes, 375 pounds		15 04
To equipment, steamer Humphreys	28 10	
To equipment, pile-drivers	46 08	
To equipment, skiffs	44 88	
To equipment, tools and appliances	88 86	
		207 92
		\$2,278 71
To labor, placing 3,328 linear feet, or 104,540 square feet revetment, for mean stage protection	1,007 55	
To stone, 3,010.6 cubic yards, for mean stage protection	2,860 07	
		3,967 62

ENGINEERING AND CONTINGENCIES.

To engineering	\$2 85	
To contingencies	128 10	
To general expense	215 05	
To surveys	58	
To telephone	33 44	
To photography	5 89	
To office furniture	92	
To instruments	2 76	
		389 59
		6,535 92

The revetment was uninjured by the high water of June, and while a portion of the west bank of the island was cut away, a deposit 6 feet thick in places was made on its surface, and the high bank at its foot was extended for several hundred feet below the protection.

Very respectfully, your obedient servant,

C. D. LAMB,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

3.

HORSETAIL BAR.

REPORT OF MR. E. D. LIBBY, ASSISTANT ENGINEER.

HORSETAIL BAR, July 5, 1883.

SIR: I have the honor to submit the following report of the operations for improvement of the Mississippi River at Horsetail Bar for the fiscal year ending June 30, 1883.

From the beginning of the fiscal year until the close of the season in December, 1882, the work consisted entirely of repairs upon the primary hurdle, and upon secondary hurdles Nos. 18, 23, 27, and 30.

Operations in the field during the second half of the year were confined to the construction of a hurdle across the chute east of Carroll's Island, and near the head of the island. Two divisions are thus naturally made of the year's work.

The detailed account of field-work at the different localities will be given in the following order, viz:

- I. Repairs.—1. Primary hurdle; 2. Secondary hurdles Nos. 18, 23, 27, and 30.
- II. Construction.—Primary hurdle—Carroll's Island.

I.—REPAIRS.

PRIMARY HURDLE.

Pile-driving.—On account of high water, work on this line could not be resumed until July 22. Upon this date the placing of piles was commenced by pile-driver No. 6: this was reinforced by No. 15 on August 1, and on October 17 by No. 3. With the exception of several interruptions in the work of No. 6, these drivers remained on the line until November 23. The total number of days on which they were thus engaged was 145.

For the most part the piles driven were in a space of about 1,300 feet, beginning at a point 400 feet above secondary hurdle No. 23. (See tracing *a-b* on primary hurdle.) A few piles were driven to repair breaks between secondaries 21 and 22, also between 25 and 27. The remainder were placed at the end of the line, near secondary No. 30. (See tracing *c-d*.)

Wattling.—Wattling upon the primary line occupied a period of twenty-five days, or from September 2 to September 8 on the breaks between secondaries 25 and 27, from October 5 to October 23 between secondary 28 and the end of the line. At the former locality 230 linear feet, average width 14 feet (3,220 square feet), was placed, and at the latter locality 1,330 linear feet, averaging 8 feet in width, or 10,640 square feet.

Placing gates.—Commencing on August 7, was completed on September 19. During this interval repairs of the gates were made from secondary No. 18 to secondary No. 21, while below 21 the work was continuous nearly to secondary hurdle 25. The gates constructed on the Missouri shore were loaded on barges, which were towed to the points where repairs were needed. From the barges they were raised and launched into position by a small force of men. In some cases difficulty was experienced in forcing them down and holding them against the piles as the current set obliquely outward from the line. Owing to this circumstance it became necessary to fasten the gates to the piles. This was done, chiefly, by spiking—in some instances by lashings leading to the main row. When the water fell sufficiently to permit, they were again spiked to the piles at the water's edge.

The form of these gates and the manner of constructing them has been given in a former report. (See Plate V and text, annual report of assistant engineer A. F. Freia, for fiscal year ending June 30, 1882.)

Mattress.—A foundation mattress 750 feet long and 50 feet wide (37,500 square feet) for repairing breaks between secondaries 22 and 24 was fabricated and sunk on August 7 to September 2; 30 feet of this mattress extended beyond the main row of piles. Another foundation mattress 1,305 feet long and 25 feet wide (31,625 square feet) was fabricated between September 11 and October 5. This was placed from secondary 28 to the end of the line.

SECONDARY HURDLE No. 18.

Pile-driving.—Owing to the high stage of water at the opening of the fiscal year, and the consequent overflow of all the hurdle lines below No. 18, work could be prosecuted upon this line only.

A single pile-driver was engaged until July 8, also on July 12 and 13, in closing a break that existed in the line at a distance of about 300 feet from the Illinois shore (*e-f* of tracing). Longer piles being required than were at hand, it was necessary to tow many that were used at this place from Arsenal Island. On July 4 a break was made in the line about 800 feet from the Illinois shore (*g-h* of tracing). This break was caused by a wreck which struck the hurdle, making a gap 350 feet in length. Repairs at this point were commenced on July 18, and on July 22 the placing of piles to close the break was completed. Two pile-drivers were employed for this work, one of which was received July 18 from Arsenal Island. A single driver continued work on this line until August 1. It was employed in driving piles to replace those that had been forced from the main line and brace row.

Mattress.—One hundred and four linear feet of mattresses for break *e-f* was fabricated and sunk on July 14 to July 19. Between July 22 and August 4, a foundation mattress 310 feet in length was constructed and sunk in the gap *g-h*. This completed the foundation mattress for the entire line.

Gates.—Placing of gates closely followed the completion of the mattress and on August 12 all of them were in position. Flats were used for this work instead of barges as on the primary line.

Bracing.—Additional bracing for a distance of 490 feet was placed upon this line.

SECONDARY HURDLE No. 23.

Pile-driving.—From September 4 until the 17th, two pile-drivers were employed in placing the piles necessary for the repairs of this hurdle line; *i-k* and *l-m* of the tracing represents the localities at which the piles were driven.

Wattling and mattress.—Wattling for hurdle 23 was commenced on September 5, and was completed on October 1. The mattress, 150 feet in length, was fabricated and sunk on the 7th and 8th of October.

Bracing required seventeen days, or from October 1 to October 18. On completing this division of the work, repairs on secondary 23 were done.

SECONDARY HURDLE No. 27.

Pile-driving.—Two pile-drivers were engaged in driving piles on No. 27 from September 17 until October 11. After the latter date one driver was used in placing braces at other points and the second driver was retained on this line until its completion.

Mattress and wattling.—From October 11 until November 20, a force was employed in placing the wattling for line 27; this time includes, however, a period of eight days on which the foundation mattress, 382 feet in length, was fabricated and sunk.

Curtains to be placed between the bar and shore were constructed on October 4 to 11. In this time 375 linear feet, average height 30 feet, were made.

These curtains, having been constructed on the bar above the line, were floated down to the hurdle and were then raised into position by a pile-driver.

In some cases it was found impossible, on account of obstructions consisting of portions of old work, to force the wattling to the bottom. To close the space between the bottom of the wattling and the bed of the river narrow curtains were employed. These were placed on November 20 to 23. This work put the line in complete repair.

SECONDARY HURDLE No. 30.

Pile-driving on secondary hurdle No. 30 was begun on November 23, and continued until the close of the season, at which time all the piles necessary for closing the line had been driven. On the tracing *n-o* represents this work at the east end of the line and *p-q* at the west end.

Mattress and wattling.—One hundred and twenty linear feet of foundation mattress was fabricated and sunk, and 1,760 linear feet of wattling was placed.

For the completion of this hurdle 395 linear feet of wattling must be placed, and 250 linear feet of foundation mattress must be fabricated and sunk.

Active work was suspended on December 6, and a portion of the force was discharged. On December 14 the remaining men were paid and discharged, their services between the 6th and 14th having been employed in collecting and securing the property for winter. The pile-drivers and other floating engineer property, except skiffs and yawls, were placed in winter harbor at Twin Hollows.

No work was done on the west side during the fiscal year. The condition of the hurdles at that location upon the close of the season was good, excepting the primary line. This, between secondary hurdles Nos. 2 and 8, received some injury during the high water.

An examination in December of the work upon the east side showed that the construction work placed in the primary line between secondaries 27 and 29 during the season of 1881 has been badly injured by running ice.

From the nature of the work, progress upon the repairs of the several hurdles has been somewhat slow. Before new work could be placed in the breaks drift was to be pulled, and oftentimes broken and leaning piles as well. In many cases it was impossible to remove all obstructions, and thus additional hindrances were to be overcome in placing the new work.

In a locality so thickly studded by sand-bars as this, the moving of plant and material from one point to another forms a large item in the work.

Nearly all the material expended in repairing the secondary hurdles had to be towed by small boats from a distance.

From September 4 to November 4, about half an hour was lost each day in crossing the river for dinner. At the latter date arrangements were made to send this meal to the workmen.

During the second half of the fiscal year it has been impossible to obtain accurate information regarding the condition of these works, owing to the fact that the river has remained at an unusually high stage. From what could be learned when the water was at its lowest it is evident that the primary line was considerably injured by the floating ice, and secondaries 27 and 30 as well, although in a less degree than the primary.

At the close of the fiscal year the river was running high over all the works at this point.

The soundings given on the tracing were taken on June 25, 26, and 27.

It was impracticable to determine new shore lines, as the river covered a large portion of the land east of the bluff. Carroll's Island was also almost entirely submerged.

The tracing shows the condition of this portion of the year's work as it was on December 31, 1882.

II.—CONSTRUCTION.

PRIMARY HURDLE—CARROLL'S ISLAND.

In accordance with instructions contained in your letter of March 14, 1883, a hurdle was commenced, on the opening of the working season in 1883, across the chute east of Carroll's Island near the head of the island, and operations were continued at this locality until the river reached such a high stage as to prevent further work of construction.

A small force was put in the field on March 20, but the equipment of quarters, the transportation of engineer property from the shore quarters on the west side, and the preliminary work incidental to the location of a new work prevented the commencement of active operations on the hurdle before March 26.

As represented on the tracing by A, B, this line extends from the head of Carroll's Island obliquely toward the Illinois shore, which it meets at a point about 1,500 feet below Dike 5. The length of the line A-B is 2,450 feet. The form of hurdle adopted consists of three rows of piles—drift, hurdle, and brace rows—foundation mattress and wattling of brush, diagonal bracing from foot of brace piles to hurdle row and from foot of hurdle piles to drift row, longitudinal stringers the entire length of drift and hurdle rows, and cross stringers from drift to brace piles. With the exception of the diagonal bracing between hurdle and drift piles the form of construction is similar to that heretofore employed.

Pile-driving was commenced in the last week of March by drivers Nos. 11, 16, and 17. Number 11 was transferred to Chesley Island on April 19; the others continued operations till the work closed for the "June rise." The small channel west of a bar, about 650 feet wide at the 20-foot stage of the river, was first closed, after which the drivers were placed on the eastern end of the line. They succeeded in driving piles to the Illinois shore, and also over the bar, before the water became too high for further work.

Mattress construction kept pace with the pile-driving, and at the close of operations the mattress had been constructed and sunk for the entire line, with the exception of about 100 feet near the Illinois shore. The foundation mattress has an average width of 46 feet, and extends from 6 to 8 feet beyond the drift row up-stream.

The wattling is continuous for a distance of 1,625 feet from the island, and is carried to the stage of the river 16 feet above standard low water. Eight hundred and twenty-five linear feet of wattling is needed to complete this part of the work on the line. Bracing and stringing were carried on at somewhat irregular intervals as small forces could be spared from the mattress and wattling gangs. Cross stringers are required for a distance of 450 feet in order to complete 850 feet of the line. Braces were hung and not bolted for some distance beyond this point; 1,875 linear feet of stringers were placed on the drift row.

The rise in the river on the last of May caused a cutting away of the island at and below the intersection of the hurdle line with the shore. To aid in protecting the island and in securing a better shore connection for the hurdle a mattress, similar in construction to a protection mattress, was commenced on June 11, at a point about 200 feet above the head of the island. This was continued until the high and rapidly rising river terminated the work of construction for the year. The mattress was 145 feet long and 51 feet wide.

The long-continued and extremely high water has interfered very much with the prosecution of the work at this locality. On May 22 the force was reduced to watchmen only. Instructions were received on June 4 to resume operations. This was done, but a heavy rise of the river soon set in, and the force was again discharged on June 18. The fleet was moved to more secure quarters on the west shore about half a mile above Jefferson Barracks.

Violent winds on many days have made the work slow and difficult, and on several it was necessary to suspend operations entirely.

Serious delays have been caused by the failure of the contractor to deliver piles in sufficient numbers and of suitable lengths. Delays from this source have affected all portions of the work.

Appended to and forming a part of this report are tables showing the progress of work during the year and giving the amount of material expended thereon.

I have been ably assisted in the prosecution of the work by Messrs. C. P. Mitchell and S. B. Cady.

Very respectfully, your obedient servant,

E. D. LIBBY,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

1216 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Tabular statement showing the amount of work accomplished during first half of fiscal year 1883.

Location.	Piles for bracing.	Piles driven.	Mattress placed.	Curtains placed.	Wattling placed.	Gates placed.	Totals.	
	No.	No.	Lin. ft.	Lin. ft.	Lin. ft.	Lin. ft.	Lin. ft.	Sq. ft.
Primary line	286	271	2,055	.....	1,560	2,512	5,772	59,196
Secondary line, No. 18	120	140	414	.....	.....	556	1,240	10,008
Secondary line, No. 23	79	150	150	.....	1,110	.....	1,110	16,050
Secondary line, No. 27	159	292	882	765	1,270	.....	1,850	36,200
Secondary line, No. 30	193	271	120	.....	1,760	.....	1,760	28,160
Total primary line	286	271	2,055	.....	1,560	2,512	5,772	59,196
Total secondary line	551	858	1,066	765	4,140	556	5,766	90,418
Totals	837	1,124	3,121	765	5,700	3,068	11,532	149,614

Tabular statement showing the amount of work accomplished during second half of fiscal year 1883.

Description.	March.	April.	May.	June.	Total.		Total.
					Linear feet.	Square feet.	
Piles driven	182	529	86	14	.....	.....	811
Diagonal braces	90	147	.....	.....	.....	237
Longitudinal stringers	12	39	.....	.....	.....	51
Cross stringers	49	.....	.....	.....	.....	49
Mattress	1,745	540	.....	2,285	104,890	.....
Wattling	832	755	.....	1,587	17,710	.....

4.

TWIN HOLLOWES, WEST BANK.

REPORT OF MR. WILLIAM S. MITCHELL, ASSISTANT ENGINEER.

TWIN HOLLOWES, WEST BANK, July 7, 1883.

MAJOR: I have the honor to submit the following report of operations for the improvement of the Mississippi River at Twin Hollowes, west bank, for the fiscal year ending June 30, 1883.

On the accompanying tracing is shown in black the work which was standing when the high water which prevailed at the beginning of the year had passed, and the condition of these works was as follows:

PRIMARY HURDLE.

The crib which had been sunk next the Missouri shore was in good condition and only required wattling to thoroughly complete it. This, however, could not be done at once on account of the drift which had accumulated in front of it. Between this crib and the upper end of the piling (Station 6+20) there existed a gap with deep water, to fill which a crib similar to the first was in process of construction. For 150 feet (Station 6+20 to Station 7+70) the hurdle had been completely broken down, and from that point to secondary hurdle No. 1 the wattling and bracing were both in need of repair.

From secondary hurdle No. 1 to a point 500 feet below No. 2 (Station 55) and two small pieces of the line 400 feet and 500 feet long, and lying, respectively, between lines Nos. 2 and 3, and immediately above No. 4, the hurdle was complete and in good condition.

The piling which had been extended 400 feet below No. 4 was also unharmed, although it was in several places so overlaid with drift as to render further work at those points impossible.

The mattress which had been sunk over the piling was intact, although, of course, it could not be seen. Had scour occurred under any portion of it, the piling, or rather a gap in the piling, would have shown it.

SECONDARY HURDLES.

All that remained in No. 1 was about 160 feet of braced piling next to the primary line. The rest had been carried out by drift. There was in process of construction a crib 203 feet \times 30 feet \times 30 feet, for the west end of this hurdle.

In line No. 2 there remained next to the primary hurdle 550 feet of piling unwattled, and in front of which there was an immense accumulation of drift.

In hurdles Nos. 3 and 4 no damage was sustained. In each instance the hurdle was complete and intact as far as it had been extended.

The high water which prevailed during June continued with a steady rise until July 5, when a maximum height (26.35 feet above standard low water) was reached. It then began falling and continued to recede until 4.4 feet was reached October 12, when it again rose slowly and stood during the remainder of the season at about 7 feet.

The weather and stage of river during the fall season was very favorable to the prosecution of the works, the only drawback being the prevalence of malarial fevers among the men, due to the previous long-continued high water. Such preventative medicines as were administered and the precaution of keeping the quarters dry and warm in the mornings and evenings had a very beneficial effect.

Although one hundred men were employed during July in the construction of the cribs already referred to, active operations were not resumed until August, during which month the force was gradually increased, reaching three hundred men September 1, when it was reduced on account of the transfer of some of the quarter boats to other works to about two hundred men, at which number it remained until November. From that time until the close of the season the force averaged only one hundred and forty men. This was in large measure due to migration of the laborers, large numbers of whom went south on the approach of winter.

The effective working force at the West Bank was still further reduced during the last six weeks of the season by a small force of men who were engaged in making repairs to and extending the hurdle at Pulltight.

The work done during the past year is shown on the tracing in red, and is also given in detail in the accompanying tables.

The zero or initial points of the hurdles, referred to in these tables, are assumed as follows:

For the primary hurdle, a point on the line of the hurdle 3,000 feet above its point of junction with secondary hurdle No. 1.

For the secondary hurdles, their points of junction with the primary line. Consequently, for lines Nos. 1, 2, 3, 4, and 5, the initial points correspond to the stations referred to in the tables as stations 30, 50, 70, 90, and 110, respectively.

There are also given tables showing the total amounts of work done in the various classes of construction and the amounts of material expended.

Hurdle.	Class of construction.	Complete July 1, 1882.		Complete July 1, 1883.		Constructed during fiscal year 1882-1883.
		From station—	To station—	From station—	To station—	
Primary hurdle (Length, 12, 130 feet).	Piling.....	7+75	94+20	6+20	94+20	Linear feet. 2, 005
	Double width mattress.....	7+75	63+60	6+20	122+50	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
Secondary hurdle No. 1 (Length, 1,000 feet).	Wattling.....	7+75	94+60	6+20	94+20	4, 075
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
Secondary hurdle No. 2 (Length, 1,120 feet).	Wattling.....	7+75	94+60	6+20	94+20	3, 800
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
Secondary hurdle No. 3 (Length, 1,200 feet).	Wattling.....	7+75	94+60	6+20	94+20	1, 020
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
Secondary hurdle No. 4 (Length, 1,400 feet).	Wattling.....	7+75	94+60	6+20	94+20	873
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
Secondary hurdle No. 5 (Length, 1,600 feet).	Wattling.....	7+75	94+60	6+20	94+20	606
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
Secondary hurdle No. 6 (Length, 1,800 feet).	Wattling.....	7+75	94+60	6+20	94+20	175
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
Secondary hurdle No. 7 (Length, 2,000 feet).	Wattling.....	7+75	94+60	6+20	94+20	300
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
Secondary hurdle No. 8 (Length, 2,200 feet).	Wattling.....	7+75	94+60	6+20	94+20	300
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
Secondary hurdle No. 9 (Length, 2,400 feet).	Wattling.....	7+75	94+60	6+20	94+20	1, 640
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
Secondary hurdle No. 10 (Length, 2,600 feet).	Wattling.....	7+75	94+60	6+20	94+20	300
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
Secondary hurdle No. 11 (Length, 2,800 feet).	Wattling.....	7+75	94+60	6+20	94+20	1, 476
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	
		7+75	94+60	6+20	94+20	

Table showing total amount of work done during fiscal year 1882-'83.

Description.	Primary hurdle.	Secondary hurdle.	Total.
	<i>Linear feet.</i>	<i>Linear feet.</i>	<i>Linear feet.</i>
Piling.....	2,005.....	3,500.....	5,505
Mattress.....	4,075 double width.....	8,353 single.....	11,508 single.
Wattling.....	3,890 × 13.....	4,495 × 13.....	8,355 × 13
Crib-work.....	250 large crib.....	506 shore cribs, 1,133 large cribs.....	1,889
Protection mattresses.....	451 feet on wire and.....	1,025 on brush stringers.....	1,476

Table showing quantities of material expended during fiscal year 1882-'83.

Material.	Primary hurdle.		Secondary hurdles.		Protection mattress.	Total expended.
	Hurdle.	Crib.	Hurdles.	Cribs.		
Bolts:						
Drift.....number.....	653		313	908		1,574
Eye.....do.....	112	150		474		736
Ring.....do.....		60	108	90		258
Screw.....do.....	196	202	411	1,030	15	1,854
Brush.....cords.....	1,423.22		1,224.58	73	993.17	3,713.97
Cleaves.....number.....	234	82	115	406		837
Lumber, pine.....feet, B. M.....				64,000		64,000
Nails:						
6d.....pounds.....						*65
10d.....do.....			150	30		180
20d.....do.....	100		724	301	300	1,425
Pile timber.....feet.....	39,950	3,914	45,324	23,309	1,837	119,354
Rope:						
Hide.....pounds.....	149		70			219
Sisal, 1-inch.....do.....	31		32			63
Sisal, 1-inch.....do.....	152	56	26	322	50	606
Sisal, 1-inch.....do.....	580	168	350	744	72	1,914
Spikes:						
6-inch.....pounds.....	750	150	680	784	900	3,264
8-inch.....do.....	700		1,035	692	400	3,827
10-inch.....do.....			243	1,924		2,167
Stone.....cubic yards.....	1,587.57	499.45	814.75	842.08	453.86	3,648.61
Washers.....number.....	125	300	110	1,336		1,871
Wire:						
No. 9.....pounds.....			475	250	3,545	4,270
No. 12.....do.....	1,300		1,200	100		2,600
No. 14.....do.....	2,328		3,593		700	6,619

* On quarters.

PRIMARY HURDLE.

The crib which was in process of construction for this hurdle was completed during July. It was 250 feet long, but for convenience in sinking it was cut in two. The sections were placed July 23 and August 2, on the line of the prolongation of the crib, which was sunk in June, and with it formed a barrier across the gap which had existed at the head of the works since their inception. The outer end of the east section of crib-work protruded beyond the line of the hurdle about 25 feet.

Immediately after the sinking the piles were redriven from the east end of the crib-work down-stream 150 feet to the main line and a mattress was sunk over them. They were then braced and wattled, and the whole line between this point and the angle (1,850 feet) was repaired. A few of the piles were straightened and some required redriving. About one-third of the braces were reset, and fully one-half of the line was rewattled.

On August 7 a small break was discovered in the line about 100 feet below secondary hurdle No. 3. Being in the pocket or angle between the primary line and the bar on the outside, a considerable stream of water was forced rapidly through it and soon widened the breach to 300 feet, scouring the bottom in the immediate vicinity from a depth of 4 feet to a depth of 12 feet.

The piles were immediately redriven, a single-width mattress was sunk over them, and curtains of brush woven on wire were dropped in front of them in the place of wattling, when the piles were at once carried out. The line was again restored, and an outside line was driven 20 feet in front of it and curving back to meet the main line on either side of the gap. A double-width mattress was made and sunk and both

lines of piles were wattled, the wattling in the original line being carried on each side to the 20-foot contour on the bars. Twice since then evidences of scour have been discovered under the mattress at the shore ends. Each time the mattress was cut to fit accurately to the bottom and was heavily weighted with stone, and the danger was removed.

Below hurdle No. 3, and above No. 4, two sections of double-width mattress were built in place on the bar. These sections are respectively 260 feet and 300 feet in length, and are separated by a space of 200 feet, in which drift had collected so heavily among the piles as to render its removal impossible.

Below hurdle No. 4 two other sections of this mattress were built on the bar. The first was 450 feet long, and extended from No. 4 to the end of the piling driven previous to July 1, which piling was also wattled. The other section was about 500 feet long, and extended that distance up-stream from the lower water edge of the bar. No piling has as yet been driven over this portion of the line.

In the 500-foot space between these two mattresses the bar is about 20 feet above extreme low water, and here it was decided to make a plantation of willows.

For this purpose six trenches were dug 2 feet apart on the line of the hurdle. They were each $1\frac{1}{2}$ feet deep, and 500 feet long, and in them freshly cut willow shoots were buried, leaving exposed only the leafy tops. The plantation was made in the latter part of September, and although the bar, which was composed of pure sand, was wet at that time, it soon dried out under the hot sun, and the willows, for want of a moist soil, died.

From the lower edge of this bar a complete section of the primary line was extended to a point 1,250 feet below secondary hurdle No. 5 (Station 122 + 50). This point was reached during the latter part of November. An attempt was then made to push the line down-stream another 200 feet, in order that the contracted channel might induce a more active scour in the bar below. It was found impracticable, however, to do this, as the rapid current which crossed the line at this point forced out the piles before a mattress could be constructed and sunk over them. A short section of mattress was placed, however, without piles across the end of the completed hurdle to prevent scour from the lower side, and the line was left for the winter.

At the close of the season the primary line was complete so far as it had been begun with the exception of 1,000 feet from the upper end of the willow plantation to the lower edge of the bar.

SECONDARY HURDLES.

No. 1.—The crib which was constructed for this hurdle was completed and sunk at the west end of the line July 21, and the hurdle itself was entirely completed from this crib to the portion of the line left standing by the high water, a distance of 570 feet.

No. 2.—On August 19, a crib 206 feet long was placed at the west end of the hurdle. While swinging into position the east end grounded on a bar which had formed during the time of its construction and remained in that position, about 20 feet up-stream from the line of the hurdle. The small gap thus formed between the crib and the hurdle was closed by driving piles across it. The 270 feet of the line between the east end of the crib and the portion of the line already in was entirely completed.

No. 3.—In this hurdle 410 feet was built at the west end of the line and 50 feet additional was wattled. Owing to a deposit of sand extending to the bank, piles were driven to the water's edge on the Missouri shore and the construction of a crib was avoided.

No. 4.—For the shore end of this hurdle a crib 150 feet long was constructed and sunk September 29. In addition the completed line was extended 300 feet farther west. A gap 80 feet wide was thus left between the crib and the hurdle through which material was taken to the works above this line.

No. 5.—A crib 144 feet long was constructed and sunk October 27 at the west end of this line, and 1,340 feet of the hurdle extending from the primary line towards the Missouri shore was completed. A gap similar to that in No. 4, and for the same reasons, was left in this hurdle between the completed section and the crib.

At the time the cribs for these last two hurdles were sunk there was practically no current crossing the lines. This permitted wattling the fronts of these structures previous to sinking. The fronts of all the others were wattled after they were placed.

In addition to the large cribs, there were built in place on the shore short crib structures averaging 85 feet in length at the extreme west ends of secondary hurdles Nos. 1, 2, 3, and 4, and extending these hurdles from the water's edge to the 20-foot contour on the bank. The fronts of all these structures were wattled.

At the close of the season the first three secondary hurdles were complete, and in the other two it only remained to close the gaps mentioned and to construct a shore crib for No. 5.

In the construction of the hurdles the ordinary methods of work, with the modifications which had proved successful during the previous year, were used, and no

especial difficulty was encountered. In each case the piling was pushed as far towards the shore as the depths of sand on the bottom would warrant, in order that the building of cribs might be reduced to a minimum, this form of construction having proved much slower and more expensive than that of the ordinary hurdle.

PROTECTION MATTRESS.

When the water had reached a low stage it was seen that a narrow strip of sand extended on the outside of the primary line from the angle above hurdle No. 1 to No. 3. This beach widened gradually to 125 feet at its lower end. From the water it ascended with a tolerably regular slope to the piling, where at a number of points it reached the 20-foot level. The slope towards the channel was much more gentle, forming in front of the training-wall a wide shoal.

During the low water, between September 1 and October 15, the river, in adjusting itself to the new regimen effected by the works between the River des Peres and Jim Smith's Landing, attempted to straighten out and form a new channel midway between the primary hurdle and the Illinois shore. In so doing this shoal was gradually deepened, and the sand beach was eaten away to the piles for a distance of 1,000 feet, to a point one-third way between secondary hurdles Nos. 1 and 2, an erosion which continued slowly during the remainder of the season. In order to protect the piles from this scour, it was decided to treat the primary line as a new bank of the river and torevet it with a broad low-water mattress.

A ways-barge and quarter-boat for the accommodation of laborers were placed in position at the head of the works October 22, and the construction of a mattress was begun. The first section of mattress was 316 feet long by 104 feet wide and extended from the shore to the outer end of the crib-work. It was woven on pairs of wires (No. 9) placed 6 feet apart. The brush was placed between the wires of each pair and the wires were then tightened by hand and twisted with a full turn to fasten them.

For 200 feet from shore it was sunk without difficulty, but from that point it went down so rapidly with the current that stone could not be distributed over it fast or evenly enough to prevent its bagging and folding up.

Another mattress, 135 by 104 feet, was constructed in the same manner and sunk over this outer portion to repair the damage done to the first. This mattress also proved so flexible and difficult to handle that it was decided to return to the ordinary method of weaving the mattress on stringers made of poles. The barges were then placed in position around the end of the cribs and a continuous mattress, begun November 11, was constructed and sunk, reaching a point 1,025 feet below the upper end of the primary line.

At first the progress made was very slow, but as the men became accustomed to the work the rate rapidly increased. Within a fortnight it rose from 25 feet to 70 feet per day, and on one day in December 102 feet were constructed. At first a row of guide piles for this mattress was driven 10 feet outside of the hurdle, the piles being spaced 20 feet apart. This was afterwards discontinued, the hurdle itself serving the purpose.

On December 6 heavy ice began running in the river and an end was put to the season's work. The barges, quarter-boats, pile-drivers, &c., were placed in winter harbor behind the primary hurdle and the bar and below hurdle No. 4.

Table showing amounts of work done from July 1 to December 6, 1882.

Description.	Primary hurdle.	Secondary hurdle.	Total.
	<i>Linear feet.</i>	<i>Linear feet.</i>	<i>Linear feet.</i>
Piling.....	2,005.	2,910.	4,915.
Mattress.....	4,075 double width.	2,910 single width.	11,060 single.
Wattling.....	3,860 × 13.	3,960 × 13.	7,820 × 13.
Crib-work.....	250 large crib.	341 shore cribs.	1,294.
Protection mattress.....	451 on wire and 1,025 on stringers.	703 large cribs.	1,478 × 104.

Work was not resumed until March 1, when a pile-driver was placed at work dredging for piles in sunken rafts, and a small force of men began the construction of cribs for secondary hurdles Nos. 4 and 5, to repair the damage done by the ice and flood of February.

The ice which broke up and passed down the river with this rise was exceptionally heavy, and did considerable damage to the hurdles. The exact extent of the damage can hardly be told, as it has been impossible to get a good view of the hurdles since that time.

From March until the middle of May the water has never been more than a few feet below the 20-foot level, thus exposing only the tops of the hurdles; and from that

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time until June 25 it rose steadily, reaching, on the latter date, an elevation 28 feet above standard low water. On June 30 it had again retired to 26 feet.

The condition of the works, however, as determined by observation and sounding, was as follows:

In the primary hurdle, from the middle of the crib-work at the head of the line to Station 7, the hurdle was submerged and probably much broken. It is not gone, however, as a distinct break in the water shows that the obstruction is still in place. In the next 1,400 feet of the line a number of small gaps appeared, none of which were at all serious. From this point to Station 28 the hurdle has been bent over by the ice, very few piles showing above the surface of the water. From secondary hurdle No. 1 to a point 450 feet below hurdle No. 5 (Station 114+50) the line is intact. Below this two breaks occur, one 150 feet wide, extending to Station 116, and the other from Station 117+25 to the end of the line. From the latter the hurdle was entirely gone.

In secondary hurdle No. 1 a small gap, about 75 feet in width, appeared at the east end of the crib.

From hurdle No. 2, the shore crib had been carried away. This was also the case in No. 3, and in the latter line an additional gap appeared between Stations 7+40 and 9+30.

The cribs which were sunk in lines Nos. 4 and 5 during the low water in the fall, having received no deposit over their floors, were not able to withstand the weight of ice which the rise in the river brought against their tops, and they were rolled over and pushed down stream several hundred feet in each instance and in to the shore.

The cribs which were begun, to replace those destroyed were completed during March, their fronts were wattled and they were sunk in place, one April 2, in secondary hurdle No. 4, and the other April 7, in secondary hurdle No. 5. A second crib for hurdle No. 4 to stand in the gap at the east end of the crib already placed was begun and completed in April, and an attempt was made to sink it May 3, when, after getting it into position and nearly to the bottom, several anchor lines broke and let one end of the crib swing through the gap in which it was to stand. After a fortnight's labor the crib was raised and strapped up to the barges and towed above the gap, and an opportunity was awaited to make a second attempt at sinking it, but on account of strong currents and high water which prevailed, no such attempt was made up to the end of the year.

In addition, for secondary hurdle No. 4, a shore crib 60 feet long was constructed.

A shore crib 105 feet long was constructed for secondary hurdle No. 3, and was sunk April 21, on which day the repair of the other break in the same line was begun. In this work, the piling was entirely replaced and the line almost braced, when a sudden rise in the river, bringing with it great quantities of drift against this new work, forced it out and, at the same time, scoured the bottom until the water on the line of the hurdle reached a depth of 40 feet.

As it was impracticable to drive piles in such depths of water with a strong current, a new line was begun east of the break, and running up stream to a point 150 feet above the gap and thence back to the line, meeting the hurdle west of the gap. This line was chosen on account of the depths of water over the greater portion of it having been found not to exceed 20 feet.

A row of drift piles was added to the line, which was entirely completed, with the exception of wattling, to within 100 feet of its proposed point of junction with the old work on the west side of the gap, when instructions were received (June 13) to close work until after the high water had passed.

The equipment having been secured, the laborers were discharged, only sufficient force being retained to tend to the idle plant and keep the crib for hurdle No. 4 free from drift, and to load several rafts of piles which were on hand on barges.

In the prosecution of these works great annoyance has been caused by the high water and the drift, which has run in large quantities. Especially has this latter been felt in the care of the crib for hurdle No. 4 and in the repair of No. 3, where, at a number of times, the whole force has been engaged for a day and more at a time in clearing the line so that the work could be carried on. At present such a mass of drift has accumulated in front of the new work in this line that it never will be possible to wattle it.

During the season the force of men employed at any one time has never exceeded seventy-five, and it has averaged about fifty.

In closing, I desire to express my thanks to Mr. J. L. Duffy, assistant engineer, for his valuable assistance in the prosecution of the work, and also to Mr. S. B. Cady, assistant engineer, who was connected with the work during the first half of the year.

Very respectfully, your obedient servant,

WM. S. MITCHELL,
Resident Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

5.

TWIN HOLLOWES, EAST BANK.

REPORT OF MR. JOHN O. HOLMAN, ASSISTANT ENGINEER.

SAINT LOUIS, MO., July 17, 1883.

SIR: I have the honor to submit the following report of the operations for the protection of the bank at Twin Hollowes, east side, for the fiscal year ending June 30, 1883.

The construction of the low-water mattress by last year's work had nearly reached Station 69, although not placed further than 59. During this year, under the direction of Mr. C. V. Mersereau, it has been completed to Station 86, which by your direction was fixed as the limit of the protection mattress at Twin Hollowes, east side. This limit was reached by the low-water mattress August 11; by the medium stage protection October 19.

The substance of this report is taken from the report rendered to you by Mr. Mersereau, January 17.

Nine hundred and sixty-four linear feet of low-water mattress was hanging from the mooring barge June 30, 1882, with the mattress gang working at its lower end. Preparations were made to sink the mattress about the 1st of July, but the rising river prevented its being placed at that time. The construction was continued until July 14, when the water had subsided sufficiently to allow it to be placed. It extended from Station 59 to Station 74, making a length of 1,500 feet. In placing, a small break occurred near Station 70, the outer edge doubling under; but when properly loaded it came back into position and was placed in good condition.

A log boom extending from the outer end of the mooring barge about 350 feet up-shore was used to protect the mooring barge and head of the mattress from drift-wood. The rising river carried so much drift-wood that it broke the boom, and five empty barges were used in its place.

On July 3 the drift-wood which had passed beneath the barges collecting under the mooring barge and the head of the mattress, parted several lines to the mooring barge and caused it to push toward shore with such force as to ride over the guide piles, breaking a large spar and tearing the capstan completely off the barge. The mattress also crowded over the piling toward the bank for about 500 feet downstream. This movement allowed a large portion of the drift to escape, thus easing the strain on the head lines. The inner edge of the barge now rested against a large tree, and was in better condition to hold than before swinging in to the bank.

As the water fell the barge was lowered onto the top of a pile. As there was about 1,350 feet of mattress suspended from the barge it could not be moved, and the pile was forced through the bottom. A bulkhead was built around the pile and packed with bags partially filled with earth. No trouble was experienced from the leak after the barge had once been pumped out.

In sinking this section of mattress all of the head lines of the mooring barge broke after the mattress had been partially loaded, allowing the head of the mattress to sag down-stream about 50 feet before it could be loaded sufficiently to hold it in place. The bank under the upper end of the mattress had caved away to such an extent that the head of the mattress when placed was but little inside of the line of low water. The water had a depth of from 40 to 65 feet and a surface velocity of about 5 miles per hour.

A section of 1,210 feet was placed August 12. As the section placed in July had passed beyond the point from which the channel left the east bank, the 1,210 foot section carried the mattress barge into comparatively shallow water and completed the mattress work at Twin Hollowes, east side. The placing of this section was easily made, as the inner edge had already settled to the bottom in two places of about 100 feet each.

From July 1 to August 11 the mattress was extended 1,516 feet; the number of working days between these dates was thirty-four, giving a daily average of about 44 linear feet per day. The number of days worked on the mattresses was twenty-nine; this would give an average of 52 feet per working day. The greatest length constructed in one day was on August 10, when 130 linear feet was made. The small daily average is partially due to the use of dry brush, as the high water prevented fresh brush from being obtained. The number of weaving-poles varied from twenty to thirty-three, according to the size of brush furnished for the construction.

On July 1, 1882, the medium-stage protection had been extended from Station 0 to Station 22, from Station 35 to Station 37, and from Station 48 to Station 49+50.

But little work was done on the medium-stage protection until the completion of the low-water mattress in August. It was then extended to Station 59, and from Station 61 to Station 86+25.

From Station 54+80 to Station 58+80 a medium-stage protection mattress was constructed to bring the mattress work into the line of low water and prevent further caving between these points. The medium-stage protection varies in height

with the nature of the bank; between Station 22 and Station 49 it is up to about the 14-foot stage; between Station 49 and Station 59, also between Station 61 and 73, to the 10-foot stage, and from Station 73 to Station 86+25 to the 12-foot stage.

The space between Station 59 and Station 61 was without medium-stage protection until May; with that exception to Station 86+25 was placed by October 19, that space being left because of the perpendicular bank. A barge load of riprap was placed between Stations 59 and 60 May 4, and one between Stations 60 and 61 on May 19.

The entire length of the medium-stage protection is 8,625 feet, of which 6,075 feet were constructed during the year.

The high water of July left very large deposits of sand from Station 0 to Station 45. From Station 3 to Station 25 but few of the guide-piles will stand in the water with the river at a 14-foot stage, and some are entirely buried. Between Station 50 and Station 73 a deposit of from 2 to 5 feet of sand was left on top of the bank, but no fill took place along the slope.

Two sets of portable quarters were in use from July 1 until September 15, when one set was transferred to Chesley Island, and the last of the same month the second set was transferred to the same place. Three quarter-boats were in use during part of July and August. Quarter-boat No. 4 was retained until October 19, when the remaining force was taken to Chesley Island.

The tracing of the progress map accompanying this report shows the condition of the work June 30, 1883. The soundings in red were taken August 1, and reduced from 13.3-foot stage to 20.2-foot stage, which was the stage when the soundings for this year's report were taken.

Very respectfully, your obedient servant,

JOHN O. HOLMAN,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

6.

PULLTIGHT.

REPORT OF MR. JOHN O. HOLMAN, ASSISTANT ENGINEER.

PULLTIGHT, ILL., July 7, 1883.

SIR: I have the honor to submit the following report of the operations at Pulltight during the fiscal year ending June 30, 1883:

The repair of the hurdle at this point and its extension towards the head of Beard's Island was placed under my charge by your order of March 19, 1883.

During the season of 1882, while under construction, these hurdles were considered as a part of the improvement at Twin Hollows, east side, but the order also changed it to a separate work, calling it Pulltight.

A primary and a secondary were constructed under the charge of Mr. C. V. Mersereau, assistant engineer, during July, August, September, and the first part of October, 1882.

A small break in the primary near its lower end was discovered October 23, and Mr. William S. Mitchell, assistant engineer in charge of Twin Hollows, west side, was ordered to repair it. This repair and its extension a short distance occupied a small force the balance of the working season of 1882.

For a detailed account I have extracted these portions of the reports of Twin Hollows, east side, rendered during January, 1883, by Messrs. Mersereau and Mitchell, that referred to the construction of these hurdles:

"During the month of June the water was making such headway down the chute behind Beard's Island that it was decided to cut it off by the construction of a hurdle line. The line adopted extended from the head of the towhead above Beard's Island to a point on the Illinois shore about 2,000 feet up-stream. The work was begun the first week in July at the Illinois shore near Station 141. The current was very strong and the water from 30 to 35 feet deep for 800 feet of the line. On Thursday, July 13, forty-five piles driven next the Illinois shore were washed out, leaving five piles standing at the outer edge of the line; the drivers were then placed further over on the line in shallow water. As the water was gaining in depth very rapidly near the shore, this line was abandoned, and six drivers were started on a secondary line directly across the chute and about 300 feet below the head of the towhead. This line was about 850 feet long, and was located with a view of closing the chute as soon as possible. The piles driven caught the refuge brush from the mattress-barge above, and the water commenced shoaling immediately both above and below the line, excepting narrow channels close to the bank at each end of the line; as the outside of the towhead was caving very rapidly, a revetment mattress 600 feet long and 45 feet wide was constructed and placed.

"On July 26 all of the piling was completed, with the exception of about 150 feet near the middle of the second row, where the water was too shoal to allow a driver to work. Considerable delay occurred in the construction of the line for the want of piles. About 600 feet of the foundation mattress was built in position, as the water had fallen sufficiently to allow the men to work on the sand-bar formed by the hurdle. The line was completed about the middle of August. The channel close to the island filled up nearly even with the bar as soon as the drift accumulated against the piles.

"The large bar above Beard's Island threw a strong current against the Illinois shore between Stations 128 and 150, causing the bank to cave badly. In order to stop this a primary hurdle was constructed from Station 113 to the first small bar below. Two drivers worked on this line, which had a length of about 1,650 feet. This line was completed about the 1st of October.

"On October 23, 1882, a break 100 feet wide was discovered in the hurdle about 120 feet from the lower end of the line. On examination it was found that the current had washed under the mattress and had forced out the piles and wattling, scouring a deep hole immediately behind the line. The damage done was entirely local. The current, after passing through the hurdle, soon lost its force, and, beyond a slight washing of the Illinois bank, did no harm. Neither the lower hurdle nor the work at Beard's Island were threatened.

"On sounding the mattress was found still in place, although not down on the bottom. Stone enough was thrown on it to force it down and hold it close to the bottom, and the scour immediately stopped.

"Two pile-drivers were placed at work, and piles were redriven in the main row, to be used as brace-piles, and a hurdle row was driven 18 feet in front of them, and curving back to the main line after the ends of the gap were passed. The piles were braced and strengthened by a top-stringer. A mattress was placed on the whole length of this new line, and the hurdle was wattled, effectually closing the break.

"The water having also scoured around the end of the hurdle, a mattress 110 feet long by 20 feet wide was sunk across the channel to the bar.

"It was afterwards decided to carry the hurdle itself to the bar, and a pile-driver was placed at this work November 29. The piling for this extension was completed for 200 feet, reaching the bar, and the piles were braced and top-stringers were bolted to them.

"A mattress 205 feet long by 20 feet wide was constructed and sunk over this new section, when the work closed for the season.

"It only remained to wattle the piling to have entirely completed the extension.

"All material and tools were brought from Twin Hollows, west bank, and all laborers were sent across in small boats, returning at noon and night to their quarters on the west side."

The passage of the ice gorges in the spring damaged both the primary and the secondary hurdles. An examination, made March 24, showed that the primary below Station 11, Station 0 being at the head of the line, had been carried away, and that a break had occurred from Station 1+50 to Station 3. The tops of all the hurdle-piles between Stations 3 and 11 had been broken off at the stringers, and in several places the wattling had been carried from the piles. The secondary was also damaged very badly; 600 feet of the 850 constructed was gone.

From the rise of the river in the spring a strong current had formed between the bar and shore, passing to the river again in front of the towhead, resulting in a very heavy scour to the towhead, the shore-line receding fully 1,200 feet to the 1st of April. The work of repairing the primary began April 1.

A force of two drivers and a complement of seventy-five men was allowed for the work at Pulltight by the superintending engineer. By April 14 the break at Station 2 was redriven, and the line repaired to Station 11. Four days later the driving in the extension to the bar reached Station 15. A space of nearly 600 feet was left for the passage of the steamer Humphreys, and the line from Station 20+70 to the bar. Station 28+60 was driven by May 8. The 600-foot gap was closed by June 8.

The following table gives the amount of work done on the primary during its construction in 1882 and 1883:

Kind of work.	1882.	1883.	Total.	Complete to station.
Piling, drift-row		2, 860	2, 860	
Piling, hurdle-row	2, 055	1, 910	3, 965	28+60
Piling, brace-row	2, 055	1, 910	3, 965	
Mattress	2, 110	1, 850	3, 965	27
Wattling	1, 910	75	1, 985	11
Stringing	2, 055	2, 860	4, 915	28+60
Bracing	2, 055	2, 200	4, 255	24+35

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Two drivers were in continuous use from April 1, to June 16. In that time 1,017 piles were driven in six hundred and seventy hours, a rate of 1.52 piles per hour. While repairing the line most of the piles were sharpened and driven with the hammer, the presence of the old foot-mattress preventing the use of the jet-pipe.

From Station 12 to the bar the driving was comparatively easy, except in closing the gap from Station 17 to Station 21, when the strong current caused by the rise in the river made the driving very difficult.

One thousand eight hundred and fifty feet of foot-mattress for the primary line was constructed with an average width of 55 feet. About half of it was built of a double layer of brush wired to a grillage of poles, but from Station 21 to the bar the form was changed to a woven mattress. It was woven on small flats fitted with ways, the piling in the three rows being cut to such a height as would just allow the weaving of the brush over their tops. With strong, pliable brush this form is more rapidly constructed and easier handled than the old form, but with small or weak brush the construction is slower and the mattress too weak for sinking in a strong current.

A mattress for the protection of the bank at the head of the primary hurdle was constructed during May, extending 290 feet above the line by 45 feet in width, and 145 feet below the line by 25 feet in width.

The stringers of the drift and hurdle rows were hung after the sinking of the foot mattress, unless the current was very strong, when they were hung immediately after the driving of the piles. The stringer of the drift-row was placed about 2 feet higher than on the hurdle-row, so that all the drift passing over the drift-row would clear the hurdle-row.

Driving on secondary No. 1 was begun June 8. Only eighty-five piles had been driven by the 14th, extending the line 200 feet from the shore end, when the superintending engineer ordered the closing of the works during the high water.

In April the towhead caved very little from the strong current passing across it, but during May the shore-line receded 600 feet. The secondary hurdle of 1882 also suffered, as all except 100 feet at the shore end was carried away. A mattress 60 feet wide was begun June 11 for the protection of the towhead during the construction of the hurdles, but only 100 feet was constructed and placed before the closing of the works, June 16.

On the tracing accompanying this report last season's work, carried away by ice, is shown by a red line. This season's work, from Station 11, is shown in black.

Drivers Nos. 10 and 21, ten skiffs, three yawls, seventeen small flats, barge-flats 28 and 32, with quarters, and the steam-launch Florence have been in service since March 27.

The *Florence* was sunk June 15, but was raised the same day with very little damage.

Appended are tables giving the service of the plant, and the material expended in construction work during the season of 1883.

I am indebted to my assistants, Messrs. A. F. Freis and B. E. Johnson, for the prompt and able manner in which they have discharged the duties assigned them.

Very respectfully, your obedient servant,

JOHN O. HOLMAN,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

7.

BEARD'S ISLAND.

REPORT OF MR. J. E. SAVAGE, ASSISTANT ENGINEER.

SAINT LOUIS, MO., July 6, 1883.

SIR: I have the honor to transmit herewith a report of the operations carried on at Beard's Island, Illinois, with a view to improving the Mississippi River, for the fiscal year ending June 30, 1883.

I assumed charge of the work as resident engineer at this locality in accordance with your orders, dated October 18, 1882, relieving Mr. J. W. Record, who was in charge up to that time.

The work performed at this locality since the last annual report has been in the line of bank protection only, and the methods pursued were in accordance with the plan adopted in 1881 and with the operations previously reported, except in some minor details of construction.

This plan embraced a low-water mattress 120 feet wide woven upon a frame-work of willow poles, to be sunk with the inner edge at standard low water; a medium stage protection, consisting of a layer 1 foot thick of riprap stone extending from

the edge of the mattress to 16 feet above standard low water, and the planting of willows for high-water protection.

Of these three classes of work the former has been practically completed, the second only partially, and no work has been commenced on the last.

On account of the increased velocity of the current encountered along the lower half of the island, it was found necessary to build a stronger mattress than was originally designed, and to sink in some places a medium stage mattress where the irregularity of the shore-line rendered it impracticable to follow the line of standard low water. Otherwise no deviation was made from the original plan.

Very little work was done in July on account of high water, and in August and September progress was delayed, by a succession of accidents and losses in the construction and sinking of the low-water mattress, accounted for by the increased velocity of the current, and the fact that the work was almost directly in the path of passing vessels. Work was continued until December 7, and in the last two months good progress was made. No work of improvement has been done since that date.

Under the headings of "low-water protection" and "medium-stage protection," and the subheadings of "grading" and "medium-stage mattress," the detailed progress of each division of the work is shown.

LOW-WATER PROTECTION.

At the date of the last annual report the island was protected by low-water mattresses from Station 0, at the head of the island, to Station 35 + 50, a distance of 3,550 feet, and a section of mattress 540 feet long had been constructed and was suspended from the mooring-barge on the water's surface.

The river rose very rapidly during the last days of June and the first of July, covering the entire upper portion of the island and rendering it necessary to discontinue weaving and to use a large proportion of the force in removing the office to higher ground and transferring the movable property to quarter-boats.

Sunday, July 2, the drift-wood began to come down stream so rapidly that quite a large gang of men was necessary to keep it from accumulating on and breaking the mooring lines. An enormous amount collected under the mooring barge and the head of the mattress, and the strain upon the lines became so great that it was decided to attempt to sink it as the only possible chance of saving it. The usual preparations were made and precautions taken. Extra barges were anchored at the outside edge and a number of extra mooring lines attached, but the loading of the mattress had hardly commenced before the lines began to part, and almost immediately the mattress broke away.

The stage of the river precluded the possibility of continuing work, and the greater part of the force was discharged, enough being retained to take proper care of the plant.

Operations were resumed with a small force July 21. A new mattress was begun at Station 35 + 50 as before, and work continued on the same until August 28, at which time 1,115 linear feet had been woven, the design being to build it continuously and to sink 1,000 feet of it about September 1. The first 250 feet of it had been built of dry brush, and was subjected to a stronger current than any previous mattress except the one lost during the high water. The upper portion showed signs of weakness the morning of the 28th, and orders were received to sink it as soon as possible. Stone was ordered and preparations made to place it the same morning; but before the ways-barge had been taken out a line attached to the outside edge, about 200 feet below the mooring barge, parted, disclosing a break, which extended rapidly in a zigzag line across the mattress. Each line parted in succession, allowing the mattress, ways-barge, and brush-barge to be swept away by the current. Some 915 linear feet of mattress were lost, but nearly all the lines were saved and the barges caught at "Jim Smith's."

As soon as practicable another mattress was started opposite Station 37 + 50, and, in addition to the regular method of construction the mattress was strengthened by the addition of splices about 8 feet long and the same size as the weaving-poles wired over each joint of the latter. Extra fore-and-aft stringers were placed between the four outside poles, running the entire length of the mattress, and wired to the brush at short intervals; and also cross stringers woven with the brush were used about every 100 feet. A strip 750 feet in length was so constructed, and successfully placed on September 16.

Weaving was commenced on another section on the 19th. This strip was almost directly in the channel which, crossing from the Missouri shore, threw its current obliquely against the bank at this point and forced passing vessels in-shore in such a manner as to seriously impede the progress of the work. Several boats having run against the mooring barge and knocked it out of position, we were obliged to sink the mattress when only about 350 linear feet were completed. Another mattress begun September 29 shared a similar fate when about 150 linear feet were woven,

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and as it seemed impossible to both construct and sink a mattress here with so much interference from steamboats and the swift current, it was decided to construct a mattress further up-stream in comparatively still water, float it to the position desired, and sink it. By this means the sinking might be accomplished in a few hours and the trouble from passing boats avoided. A section 325 feet in length was so constructed, but in attempting to float it down to the required position some of the lines parted, and before its progress could be checked it was carried about 150 feet too far. It was made fast here in the usual manner, and sinking commenced the following day, but it had become considerably wrenched and weakened by coming in contact with the guide-piles while being floated down, and during the sinking process broke into several pieces, and a large proportion of it was lost. A strip 175 feet in length was picked up by the steamer Humphreys, towed to Chesley Island, and made use of there, but the small amount sunk at Beard's Island formed no efficient protection.

The bank below the last-mentioned mattress having wasted away nearly 200 feet, the next one was commenced nearer shore, lapping the previous one on the inside edge and forming a re-entrant angle in the protection. Weaving was commenced October 21, the design being to build a continuous mattress. About 1,200 linear feet were completed before an attempt was made to sink any, and on November 13 1,050 linear feet were successfully placed. The weaving was continued on the same section until November 21, 200 additional feet having been placed meanwhile, and the mattress had passed the end of the island proper and was subjected to a very strong cross-current, and an immense strain from accumulated drift. On the afternoon of the above date the ways of the mattress-barge broke close to the gunvane, and made it necessary to launch and sink the mattress and repair the ways before continuing. The entire section thus completed was 1,450 feet in length. Weaving was resumed two days later and continued until December 6, at which time work was suspended for the season, the river being filled with floating ice. This section of 680 linear feet was successfully placed, and completed a continuous low-water protection from Station 0 to 75 + 50.

The total amount of 120-foot-wide mattress constructed in the fiscal year was 4,850 linear feet, but in addition to this a mattress 100 feet wide—mentioned under "Medium-stage mattress"—and 325 feet long was built below Station 75 + 50, being partially low water and part medium stage protection.

Statistics of progress computed on the 120-foot mattress commenced at Station 49 + 75, and ending with the year's work at Station 70 + 55, give the following results: The total number of hours' labor was 25,752, the number of days actually worked thirty-nine, and the number of linear feet constructed and placed 2,160. These figures give an average of 0.84 linear foot per man for each ten hours' labor, and show an average of sixty-six men building and sinking about 55 linear feet per day.

MEDIUM-STAGE PROTECTION.

The medium-stage protection of riprap stone had been carried June 30, 1882, to Station 16 + 50, 1,650 linear feet from the head of the island. During the latter part of July this work was extended to Station 18, the whole strip being carried to the required stage, 16 feet above standard low water. The river fell so low in August that it was impracticable to continue this section on account of the bar which had formed outside the line of guide-piles, and work was commenced at Station 28, leaving 1,000 linear feet of bank that has received no riprap, and continued from time to time as stone could be procured until November, when it proceeded almost continuously till the end of the season. Most of it, however, was carried only to the 10-foot stage or 6 feet above standard low water.

The total length of bank revetted with stone during the year was 3,500 feet, of which 850 linear feet was carried to the required stage and 2,650 linear feet to the 10-foot stage. The former was between Stations 16 + 50 and 18, Stations 28 and 33, and Stations 40 + 50 and 42 + 50; the latter extended from Station 33 to Station 35, from Station 35 + 50 to Station 40 + 50, from 42 + 50 to Station 59, and from Station 62 to Station 65.

GRADING.

The steep bank inside the guide-piles below Station 35 necessitated excavation and grading before the medium-stage protection could be placed. For this purpose a steam hydraulic excavator was employed during the last of October and first of November, grading 1,043 linear feet of bank between 14 and 20 feet high to a slope of 2 to 1. The number of cubic yards excavated was estimated at 15,452; the total cost of labor, supervision, and fuel, \$217.77, making an average cost of 1.4 cents per cubic yard, and about 21 cents per linear foot of bank graded. A small amount of grading was also done by hand labor, but the above cost represents only that done by the excavator. The hydraulic excavation was carried on fifteen days, and its economy and rapidity were fully proven. Very little difficulty was experienced in cutting the bank to the desired slope.

MEDIUM-STAGE MATTRESS.

During almost the entire year the current followed and seemed to keep just ahead of the completed protection, cutting the bank in an irregular manner, and making it impossible to sink the inside edge of the mattress at the line of standard low water. This cutting was especially active between Stations 44 and 50, and it was found necessary to build a medium-stage mattress for this distance of an average width of 80 feet. The construction of this mattress was similar to that of the hurdle-foundation mattress, and consisted of two layers of brush placed at right angles with a strong grillage above and below, the whole being lashed and wired together on large flats and sunk in place.

A similar mattress, 60 feet in width, was commenced October 30 at Station 64, designed to protect the low bank or bar below the island proper, where the slough had filled to about the 15-foot stage. About 900 linear feet were built of this width and a triangular strip 200 feet long with a 40-foot base added at its upper extremity to widen it and to lap the edge at the low-water mattress. The design was then changed to a 100-foot wide mattress, to be woven on temporary ways placed on large flats. This mattress protected the bank both as low water and medium stage mattress, but in the summary is regarded as low-water protection; 325 linear feet were constructed, extending from Station 72+50 to 75+75.

The total length protected on the bar was 1,175 feet, and the dimensions of each mattress less than 120 feet were as follows: between Stations 44 and 50 a section 600 by 80 feet; between Stations 64 and 73 one 900 by 60 feet, and the triangular piece mentioned above; and below Station 72+50 a section 325 by 100 feet.

The accompanying sketch, Plate V, shows the relative position of the bank at the beginning and end of the year, the comparative depths of water, and the extent and location of the work constructed.

The following table shows the amount and cost of the material expended on each class of work, and a statement of the amount of each kind completed to date:

Material.	Low-water mattress.	Medium stage protection.		Total.
		Mattress.	Rip-rap.	
Brush.....cords..	4, 117. 01	1, 149. 20	.....	5, 266. 21
Stone.....cubic yards..	2, 203. 95	667. 49	3, 362. 19	6, 233. 63
Piles.....linear feet..	14, 832	5, 909	.....	20, 741
Piles.....number.....	423	161	.....	584
Spikes, 8-inch.....pounds..	5, 250	.....	.....	5, 250
6-inch.....do.....	1, 450	1, 350	.....	2, 800
Wire, No. 14.....do.....	.....	1, 500	.....	1, 500
No. 12.....do.....	7, 755	25	.....	7, 780
No. 10.....do.....	550	.....	.....	550
No. 9.....do.....	1, 005	.....	.....	1, 005
Nails, 20d.....do.....	655	100	.....	755
8d.....do.....	200	.....	.....	200
Steel rope.....do.....	1, 201	1, 702	.....	2, 903
Steel yarn.....do.....	.....	110	.....	110
Round iron.....do.....	203	.....	.....	203
Screw-bolts.....number..	20	.....	.....	20
Drift-bolts.....do.....	300	.....	.....	300

Kind of work.	1881 to 1882.			1882 to 1883.			Total protected to date.
	Constructed.	Laps and losses.	Total protected.	Constructed.	Laps and losses.	Total protected.	
Low-water mattress.....	4, 500	950	3, 550	5, 175	1, 245	3, 830	7, 380
Medium-stage mattress.....	.....	.....	.....	1, 500	.....	1, 500	1, 500
Medium-stage riprap, 10-foot stage.....	.....	.....	.....	2, 650	.....	2, 650	2, 650
Medium-stage riprap, 20-foot stage.....	1, 650	.....	1, 650	850	.....	850	2, 500
Grading.....	.....	.....	.....	1, 043	.....	1, 043	1, 043
Primary hurdle.....	960	.....	960	.....	.....	.....	960

No work of improvement has been done since December 7, 1882; but, with the exception of a slight grading action above the partially completed protection of riprap, no cutting or caving of the bank has occurred, while the soundings show a general

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fill from sediment deposits the entire length of the island. Previous to the commencement of the protection work the island was wasting away, by the action of the current, at an average rate of about 10 feet per week for its entire length, and its present condition proves the efficiency of the work.

After taking charge of the work in October, I was ably assisted by Mr. C. P. Mitchell, assistant engineer, to whom I desire to return thanks.

Very respectfully, your obedient servant,

J. E. SAVAGE,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

• 8.

CHESLEY ISLAND.

REPORT OF MR. C. V. MERSEREAU, ASSISTANT ENGINEER.

CHESLEY ISLAND, MO., July 7, 1883.

SIR: I have the honor to submit the following report of operations at Chesley Island for the year ending June 30, 1883:

The bank protection at Chesley Island was begun on September 15, 1882, and continued until December 14, 1882, when the work was suspended on account of the close of navigation.

On March 19, 1883, orders were received to resume work as soon as practicable. The quarters were occupied on March 22, and active operations were resumed on the arrival of material on March 26, 1883, and continued until June 15, 1883, when the high water caused the suspension of active work.

There were constructed during the year ending June 30, 1883, 4,305 linear feet of low-water mattress 120 feet wide; 4,404 linear feet of low-water mattress 120 feet wide were placed, of which 174 linear feet came from Beard's Island; 3,475 linear feet of medium-stage protection carried up 16 feet above standard low water and averaging about 65 feet wide; 1,010 linear feet of medium-stage protection carried up 8 feet above standard low water and averaging about 25 feet wide; 2,760 linear feet of grading cut about 36 feet wide and 18 feet deep; 350 linear feet of medium-stage protection mattress 50 feet wide; 550 linear feet of low-water mattress about 40 feet wide; 759 piles driven; 720 feet foundation mattress 50 feet wide.

Preparations for the bank protection at Chesley Island were begun about the middle of September, 1882.

One set of portable buildings was taken from the works at Twin Hollows, east side, and erected on the island about a quarter of a mile below the head, this being the highest ground available for the purpose.

This portion of the island was covered with a thick growth of young cottonwoods and sycamores, which had to be cleared off before the ground was available for the erection of the quarters.

Pile-driver No. 14 was brought from Twin Hollows, east side, on September 19. Two clumps of four piles each were driven about 400 feet above the head of the island and in the shoal water across the head of the chute. A third group of five piles was also driven just above the high bank at the head of the island and firmly braced together. By resting the inshore end of the mooring barge against the third group of piles and making the head lines fast to the two clumps of piles above the island the mattress work was commenced at the head of the island.

Mattress barge No. 3 arrived from the engineering depot September 22, and the construction of the low-water mattress, 120 feet wide, was immediately begun. Twenty-five weaving poles were put in at the commencement, but the brush being large, the number was reduced to twenty-three. A grillage of poles was placed under the head of the mattress to strengthen it, but was discontinued after the first 50 feet, as it offered too great a surface to the resistance of the current. After dropping the grillage four stringers were run along under the outside edge of the mattress and a cross-piece put in every 100 feet to give good fastenings for mooring lines.

On October 19, 840 feet of mattress was placed, and about 400 feet left floating. The mattress was continuous, the inclined portion being held in position by lines from a mooring barge placed across the mattress and from shore.

The soundings made during the construction of this portion of the mattress gave an average depth of about 24 feet; on placing the mattress the depth was about 35 feet, the stage of the river being about the same.

The placing of the remainder of the mattress was done at intervals, the mattress barge generally being from one to three days' work in advance of the mooring barge. Sufficient stone was usually kept on the mooring barge to sink the whole of the mattress floating in case of an accident.

On November 4 a small break occurred at the outer edge of mattress at station 20, being just below the mooring barge. In sinking on the following day the break was extended in to about 40 feet; the corner doubled under and tore a triangular shaped piece about 40 feet by 100 feet from the outside edge of the mattress.

On December 5 the mattress was finished and placed to Station 43+05. It lapped about 15 feet on the piece of mattress 174 feet long that floated down from Beard's Island on October 14, and which had been placed as far down the bank as it was thought necessary to extend the mattress work.

The total length of the mattress work is 4,464 feet, of which 4,305 feet was constructed continuously and placed with but one small break in it. This break extended only one-third across the mattress and impairs its value as a protection but little.

The total number of working days from the commencement to the finishing of mattress was 64. This gives a daily average of 67 feet per working day. The number of days spent on construction was fifty-nine, of which six half days were lost on account of bad weather, leaving fifty-six days worked; this gives an average of 77 feet per day worked. On fourteen of the fifty-six days worked the average number of hours was less than two hundred, or less than one-third the number of hours of a full gang. The largest amount constructed in a single day of nine hours' work was 126 feet. Two days gave 120 feet each, and four other days gave over 100 feet each.

The mattress was placed in from 24 to 30 feet of water on the outside edge, with a stage of water of about 6 feet above standard low water. The steamboat channel was close to the bank and the current had a velocity of about 3½ miles per hour. The soundings taken during the construction showed the water to be of nearly uniform depth on the outside 90 feet of the mattress.

In compliance with your orders of March 19, 1883, preparations were at once made for the construction of a low-water mattress, 40 feet wide, to be placed on the west side of the head of the island.

On March 27 pile-driver No. 5 was received and commenced driving piles from which to suspend the mattress, about 100 feet above the head of the island. The mattress was commenced on March 31 and continued until April 10, when the entire section, about 550 feet long and 40 feet wide, was placed in from 18 to 34 feet of water, the Saint Louis gauge reading about 18 feet. The mattress was woven on eight poles, the ways being carried on five small flats.

The medium-stage protection had been placed from Station 0 to Station 39 before the suspension of the work in the winter. It had an average width of about 30 feet, and extended from the edge of the low-water mattress to about 6 feet above standard low water, with the exception of a space of about 100 feet at the head of the island, which extended about 12 feet above standard low water.

Work was resumed on the medium stage protection on March 26, 1883, and stone has been placed wherever available during the season. The riprap from Station 0 to Station 28+90 has been extended up the bank to 16 feet above standard low water, and has an average width of about 65 feet. A large portion of this work was done at a high stage of water, and will probably require some leveling off when the water will permit.

On the west side of the head of the island 585 linear feet of riprap, extending from the edge of the small low-water mattress to about 14 feet above standard low water, was placed. The stone could not be carried to the 16-foot stage on account of a bluff bank above the 14-foot stage, but sufficient stone was left along the upper edge of the work to carry it to the 16-foot stage as soon as the bank grades back.

A medium-stage protection mattress around the head of the island, to protect it from caving and to prevent the undermining of the head of the low-water mattress, was begun October 27, 1882. This was commenced about 400 feet above the head of the island, and a strip of about 50 feet wide extended down nearly to the head of the low-water mattress. Owing to the scarcity of brush the mattress was dropped and three barge loads of stone were placed on the channel side of the island above the head of the mattress.

On November 15 the hydraulic excavator arrived from Beard's Island and began work at the head of the island; it worked down the bank to Station 27+50. The average height of the bank excavated was about 18 feet; the grade of 2 to 1 could not be cut on account of the lower stratum of the bank being coarse sand, which washed out very rapidly. The average slope is about 1½ to 1, but from the edge of the mattress to the top of the bank would give an average slope of over 2 to 1.

During the latter part of November a pile-driver was sent from Twin Hollows, west side, to be tried as an excavator. It was found to work well in cutting the bank, but the volume of water was too small to wash away the fallen earth with rapidity. About 50 linear feet a day could be graded with it.

The grading extended over about 2,800 linear feet; the average width of cut was about 5 feet, and the average height of cut 18 feet. This would give for amount of excavation about 32,600 cubic yards.

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A hurdle line across the chute behind Chesley Island was commenced April 13, 1883, and work on it was continued until June 15, when it was suspended on account of high water.

The line was located about 1,000 feet below the head of the island, 700 feet below the mouth of the Meramec River, and about 100 feet above the towhead of First Island. One pile-driver (No. 11) was employed until May 18, when the second pile-driver (No. 20) was placed on the line. The line was commenced at the east or island end and pushed toward the Missouri shore. When about 500 feet of the line had been driven the driftwood ran so heavily that the pile-drivers were taken to the Missouri shore and about 300 feet of line driven from that end before the work was suspended.

Most of the driftwood in the river passed down behind the island, and a large mass accumulated there. On June 5 the driftwood, extending about 800 feet above the line, went out in a body. As the water was about 6 feet above the tops of the piles but little damage was done; 363 piles were driven, 10 stringers placed, and 720 feet of foundation mattress were placed, 580 feet of which were at the east end and 140 feet at the west end of the line; 240 linear feet at the west end of the line was braced with large poles at about the 27-foot stage. Fifty feet of curtain was placed at the east end of the line.

The location of the work was made from Station 17 of survey of 1874 and Station 20 as located by Mr. John O. Holman, assistant engineer, and was afterwards checked from Stations 23 and 25 survey of 1874.

The sketch transmitted herewith shows condition of the work on June 30, 1883. The soundings in red were taken December 4, 1882, and are reduced to same stage as those in black, which were taken June 30, 1883.

In closing, I desire to express my thanks to Mr. John W. Irwin, assistant engineer, for the very valuable assistance rendered and the interest he has taken in the work.

Very respectfully, your obedient servant,

C. V. MERSEREAU,
Resident Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

9.

"JIM SMITH'S."

REPORT OF MR. JOHN O. HOLMAN, ASSISTANT ENGINEER.

PULLTIGHT, ILL., July 7, 1883.

SIR: I have the honor to submit the following report of the operations at "Jim Smith's" during the fiscal year ending June 30, 1883:

The hurdles for the improvement at Jim Smith's include a primary and nine secondaries.

Construction work began at the upper end of the inclined primary June 1, 1882. During that month 1,500 feet of drift row, 900 feet of hurdle row, and 850 feet of brace row were driven.

July, 1882, opened with high water, necessitating suspension of work until the 17th. From then the work progressed continuously until the closure in the fall, which occurred the 6th of December.

Work was in progress on the primary, and the secondaries from one to seven, inclusive.

The following tables are given to show the amounts of piling, mattresses, &c., constructed in each month on the different hurdles, ending with the totals constructed during the half year:

PRIMARY HURDLE.

[F to F, 3,820 feet + F to E, 13,325 feet = 17,145 feet.]

	July.	August.	September.	October.	November.	December.	Total.
Piling.....	840	1,270	930	3,300	1,005	.....	7,355
Stringing.....	800	1,250	600	3,375	1,405	.....	7,430
Mattress.....	680	1,270	600	950	2,000	300	5,800
Bracing.....	700	1,050	1,120	950	2,000	600	6,420
Wattling.....	300	1,500	600	520	2,400	.....	5,320

SECONDARY No. 1.

[870 feet long.]

	July.	August.	September.	October.	November.	December.	Total.
Piling	700	170					870
Stringing		470	400				870
Mattress	550	320					870
Bracing		870					870
Watling		870					870

SECONDARY No. 2.

[1,940 feet long.]

Piling		1,440	250	200	500		2,300
Stringing			1,690	200	450		2,340
Mattress		1,140	550	200	450		2,340
Bracing			1,190	450	250		1,890
Watling		340	600	700	250		1,890

SECONDARY No. 3.

[1,600 feet long.]

Piling		475	270	475	225		1,445
Stringing			745	475	225		1,445
Mattress		475	270	475	225		1,445
Bracing			475	745	225		1,445
Watling			475	495	225		1,195

SECONDARY No. 4.

[1,250 feet long.]

Piling				325	250		575
Stringing				325	250		575
Mattress				325	250		575
Bracing					575		575
Watling					575		575

SECONDARY No. 5.

[1,050 feet long.]

Piling				1,050			1,050
Stringing				1,050			1,050
Mattress				800	250		1,050
Bracing					1,050		1,050
Watling					1,050		1,050

SECONDARY No. 6.

[1,300 feet long.]

Piling			580	170			750
Stringing			580	170			750
Mattress				750			750
Bracing				750			750
Watling				750			750

TOTAL CONSTRUCTED.

	July.	August.	September.	October.	November.	December.	Total.
Piling	1,550	3,355	2,550	5,520	1,980	-----	14,955
Stringing	800	1,720	4,535	5,595	2,330	-----	14,980
Mattress	1,230	3,205	1,940	3,500	3,175	800	13,350
Bracing	700	-----	2,785	2,895	4,100	600	13,000
Wattling	300	2,710	1,675	2,465	4,500	-----	11,650

When the river receded to a working stage on the 17th, construction work was begun. Two barges with portable quarters and two sets of portable quarters on shore, capable of accommodating three hundred and fifty persons, were then in use, although during the first week of July only ninety-nine persons were employed.

The high water flooded the men's quarters in the upper set of buildings, and caused the moving of the building of the lower set, but no other damage was done to them by the high water.

The seven pile drivers, Nos. 1, 2, 5, 7, 18, 19, and 21, then stationed at this work, were idle until the 12th of July, when four of them were used in pulling drift preparatory to driving, which was resumed on the 17th. No. 21 was taken to Twin Hollows July 21.

Three of the drivers were placed on the primary and two on secondary No. 1. Driving on No. 1 began at the shore end and was carried toward the primary, closing with it August 25, although on August 5 it was within 50 feet of closing, that space being left for the passage of the drivers and barges working above. After the drift had been cleared from the primary between Stations 9 and 9+50, that line was carried continuously down stream until August 5, having then reached Station 22, where the first break occurred in the line extending the 200 feet between Stations 19 and 21. This break was caused by the accumulation of drift coming from the caving bank at Beard's Island, the piling in the drift row breaking and carrying the hurdle row with it. The drift row above Station 19 was held by the floating mattress, which had then been constructed to Station 1+50, although more drift had gathered above Station 19 than below. To prevent further breaks, piles were placed across the row connecting with the drift hurdle and brace piles, which braced the row during the building of the mattress and the placing of braces. This cross-bracing was continued with the driving of the line as far as Station 29, which was reached August 25.

It was then decided by the officer in charge to connect the work with the channel bar, and the drivers were moved to the bar, driving up stream, so as to connect some distance from the bar. Driving was also begun at the same time at the bar end of No. 2, working shorewards. In the mean time No. 2 had been driven since the 1st of August from the shore to Station 6+40, and also No. 3 since the 20th of August had been driven 350 feet from shore to Station 12+50.

These secondary lines were protected in a great measure from drift by the primary line, and in their construction only the hurdle and brace rows were used with cross-braces, but the stringers were placed on the hurdle row as soon as driven.

On Monday, the 28th, with the hurdle lines carried to about the distance as above mentioned, the mattress from Beard's Island, with two barges attached, managed to pass through without doing any material damage to the hurdle lines. The mattress, about 800 feet long, came down broadside on, with two barges attached to the river end, the shore end of the mattress striking the primary at about Station 23. Both barges swung around the end of the primary without striking, and were finally caught as they passed No. 3 hurdle. The mattress went through, breaking all of the lines fastened to it as it passed the different hurdles.

During July and August the employes, the maximum being 202, were mostly disposed of in two sets of quarters, one on barge No. 29 and the other on shore above hurdle No. 2. The quarters at the end of No. 6 hurdle were used only by a few. A set of buildings taken from Twin Hollows, east side, were erected just below the lower quarters during the first week of September, and were ready for use on the 7th.

As the *Humphreys* could not land at the upper buildings, it was decided to move them to the lower landing, and on the 15th they had been moved and were ready for use. The drivers were also increased in number from six to eleven during the first week of September by the arrival of No. 17 on the 4th, Nos. 8 and 11 from Cape Girardeau on the 6th, and Nos. 9 and 10 from Twin Hollows on the 7th. But even with the extra drivers and quarters less work was done in September than in August, on account of the chills and fevers then prevalent in the camp. It was near the end of September before crews could be found for all of the drivers.

A break of 250 feet in line No. 2 occurred between Stations 9+50 and 12 which, was repaired during September, and only from Stations 6 to 8 remained undriven.

The primary line was closed on the 21st, and by the end of the month it had been entirely finished from the shore to the bar except 500 feet of wattling between Stations 29 and 34.

Until the 21st all the driving had been done on secondaries 1, 2, and 3, and on the primary above F, but the drivers were then moved from the primary to hurdles 6 and 7, driving from the bar.

In October the drivers made the best showing, driving 5,520 linear feet of hurdle line. No. 5 hurdle, 1,050 feet long, was driven between October 9 and 21, in the week ending October 21, No. 4, began October 12, was extended 325 feet from the bar. No. 6 hurdle and the gap in No. 2 was finished on the 13th, the gap in No. 3 finished on the 20th, and 3,200 feet of primary driven between hurdles 4 and 7.

In November 1,980 linear feet of hurdle was driven, 850 of it on the primary between 4 and 7, 250 of it on No. 4, and the balance in repairing the breaks of the hurdle lines.

The force of laborers was more than doubled to keep the construction of mattress, wattling, &c., up with the driving. From 202 on September 1 an increase was made to 356 on October 1, and to 545 on November 1. To keep this force, three barges with quarters, one quarter boat, and three sets of quarters on shore were in use with a total accommodation for five hundred and seventy-nine men.

The rise in the river during the week ending October 21 caused a caving under the mattress at the bar end of the primary. As the mattress lowered, the bar began caving very rapidly. No. 2 hurdle gave way again between Stations 7+50 and 12, and No. 3 followed by breaking between Stations 6+50 and 8. The caving after it extended around the bar end of No. 2 on the 24th was very rapid. These breaks in Nos. 2 and 3 were repaired, as also another of 75 feet in No. 3 hurdle at Station 10. The final break occurred in No. 3, between Stations 13 and 14+25, the repair of which was in progress when the work was stopped.

The break at the end of the primary was, of course, due to the water crowded between the channel bar and the primary hurdle, but in the secondaries, when the water passed through the whole length of the wattling, these breaks were due to the undermining of the mattress.

The double thickness of brush as well as the stringers used in the construction of these foot-mats, render them too stiff to lay closely to the bottom unless loaded with over amount of stone; and in cases similar to hurdles 2 and 3, where the water was checked by the wattling and held between the bar and shore, it required but a short time to undermine the hurdle at some point, relieving the balance of the line by a washout.

A foot-mattress, constructed similar to the protection mattress, where the brush by weaving could be made double width instead of double thickness, would be better for resisting the scour.

Between point F and hurdle No. 4 on the primary, four rows of willows and one of cottonwoods were planted. This work consumed the time of a sub-overseer and sixty men from 9th to 28th of October. The willows and cottonwood cuttings were procured from the Illinois shore opposite the channel bar, and the wagons loaded with these brush cuttings were ferried across in flats at hurdle No. 4; 450 feet of the line was lost by the caving of the bar between Stations 0 and 4+50.

The steam-launch Florence has been in service since the 1st of August, rendering valuable service in moving small flats, piles, and pile-drivers, although not worked to her fullest capacity on account of her light build.

Beginning with December, the force of laborers was rapidly reduced, the floating property transferred to Twin Hollows, and the property remaining left in charge of Wm. Lee, overseer.

The hurdles suffered greatly by the running of the ice in the spring.

The following table gives the length of the hurdle lines standing January 1 and April 1:

Hurdles.	Standing January 1.	Standing April 1.	Loss.
No. 1	870	300	570
No. 2	1,890	850	1,040
No. 3	1,220	320	900
No. 4	575	150	425
No. 5	1,050	270	780
No. 6	750	670	80
No. 7	100	100	.....
Total	6,455	2,660	3,795
Primary	4,575	2,875	1,700
Primary inclined	3,550	2,650	900
Total	8,125	5,525	2,600

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Another break occurred in the primary from Station 2+70 to 5+50 the last of May. These changes are shown on the tracing accompanying this report. The full blue line on the primary to Station 7, with a broken line to Station 15, shows the length of line constructed to June 30. The dotted part was washed away by the high water of July, 1882. The dotted red lines on the primary and secondaries show the portions carried away since January 1, the full black lines, the portions of the hurdles now standing. The full green line to Hurdle No. 4 shows the length of willow-planting on the bar.

No construction work has been done this season. Two of the portable buildings, with their outfit, were placed on Barge No. 32 for service at Pulltigh. The remaining property was transferred to the depot.

Very respectfully, your obedient servant.

JOHN O. HOLMAN,
Resident Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

10.

FOSTER'S ISLAND.

REPORT OF LIEUTENANT FREDERIC V. ABBOT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., July 3, 1883.

SIR: I have the honor to transmit herewith my annual report upon the work done at Foster Island during the fiscal year ending June 30, 1883, with a view to improving the Mississippi River in that vicinity.

I assumed charge of this work on the 13th of June, 1883, relieving Mr. J. A. Worthen. My report covers the operations of the entire year.

A set of portable shanties for quarters was erected at Foster Island in September, 1882, with the expectation that the works near Cape Girardeau, Missouri, would be completed, and the engineer assistants and plant there in service would become available about the 1st of October. They did not arrive till October 25, and from that date till November 9 Mr. J. A. Worthen, the resident engineer, assigned to this locality, was engaged with his force in erecting shanties and making the necessary preparations for beginning a new work.

These preliminaries having been completed November 9, a mattress to protect the shore of the island below standard low water against the further advance of the river was begun as near the head of the island as a large sand-bar, which had formed during the preceding high water, would allow.

The head of the mattress was supported on piles instead of on a barge, as is the usual method, because the depth of water was slight, and the approach of freezing weather rendered it inexpedient to risk getting a barge hard aground in a position so exposed to running ice.

The width of the mattress, 105 feet, was 15 feet less than the standard, because no regular ways-barge was available, and the barge flat used for the purpose was not long enough to accommodate the usual number of ways. Care was exercised to sink the mattress so that its outer edge was 120 feet on the channel side of the curve of standard low water, so that in the future the zone 15 feet wide between the inshore edge of the mattress and this curve can be protected without difficulty.

But 580 linear feet of mattress had been completed and placed when navigation closed, and work was suspended for the winter. This occurred December 1, 1882, only twenty-two days after the work had been begun. Part of a barge-load of stone remained after the mattress had been placed, and this was distributed as medium stage revetment, near the upper end of the protected bank.

That so little was accomplished was largely due to many unfavorable circumstances. The force of laborers varied constantly between ten and fifty, no men remaining long enough to become expert, but all leaving after they had earned money enough to pay their passage south, where they intended to work on the lower river. The weather was severely cold.

Since December 1, 1882, no work of construction has been done at this locality on account of prevailing high water. The condition of the bank has been examined from time to time, and on April 30, 1883, the shore line was surveyed; it is shown on the accompanying Plate, No. —, in a full line. The shore-line in 1881 is also shown, in

* Plate not forwarded.

dotted lines; that on December 1, 1882, in broken and dotted lines. The plate shows that the shore has receded between 100 and 200 feet, about ten acres having caved into the river.

The position and extent of mattress sunk is shown in broken lines; the stone placed as medium stage revetment is seen near the point M. M N is a chained base; its two extremities are located with reference to points 27 and 29 of the general survey of the Mississippi River between the Illinois and the Ohio rivers, made under this office.

Work will be resumed at this locality as soon as the river has reached a sufficiently low stage.

Following is a detailed statement of expenditures for labor and material.

DETAILED EXPENDITURES FOR LABOR AND MATERIAL AT FOSTER ISLAND, FOR FISCAL YEAR ENDING JUNE 30, 1883.

Low-water protection :

To labor, constructing mattress.....	\$490 86	
To labor, sinking mattress.....	17 72	
		\$508 58
To brush.....		1,390 00
To labor, driving piles.....	60 73	
To pile timber, sixty-six sticks driven.....	199 27	
To pile timber, eight sticks miscellaneous.....	24 16	
		284 16
To stone.....		167 39
To rope.....		33 35
To wire.....		53 50
To iron.....		2 27
To nails.....		4 80
To spikes.....		18 80
To subsistence, service at locality.....	396 11	
To subsistence, provisions.....	472 74	
To subsistence, contingencies.....	94 28	
		963 18
To equipment, steamer Anita.....	80 30	
To equipment, steamer Humphreys.....	134 88	
To equipment, pile-drivers.....	45 44	
To equipment, barge flats.....	68 22	
To equipment, skiffs.....	50 40	
To equipment, tools and appliances.....	98 60	
To equipment, quarters.....	218 40	
		696 24
		\$4,122 22

Mean stage protection :

To labor, placing stone.....	\$20 25	
To stone.....		118 75
To subsistence, service at locality.....	\$20 85	
To subsistence, provisions.....	30 11	
To subsistence, contingencies.....	1 20	
		52 16
To equipment, steamer Humphreys.....	16 86	
To equipment, quarters.....	8 40	
		25 26
		\$216 42

Engineering and contingencies :

To engineering.....	506 00	
To contingencies.....	649 06	
To general expense.....	241 50	
To surveys.....		1 16
To telephone.....		36 96
To office furniture.....		1 34
To instruments.....		4 52
		1,440 54
Total.....		5,779 18

Very respectfully, your obedient servant,

FREDERIC V. ABBOT,
First Lieut. of Engineers.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

PIASA ISLAND.

REPORT OF MR. C. D. LAMB, ASSISTANT ENGINEER.

SAINT LOUIS, MO., July 6, 1883.

MAJOR: I have the honor to submit the following report of operations at Piasa Dam during the fiscal year ending June 30, 1883.

The chute on the Illinois side of Piasa Island had been used as the steamboat channel for several years, but has been run with constantly increasing difficulty on account of the large bar which had worked down across its head. When the river fell below a medium stage in August, 1882, steamboats were obliged to pass down the west side of the island crossing the dam near the Missouri shore. The crest of the dam was lower at other places, particularly near the island, but steamers could not get to and from these depressions with safety on account of shoal water above and below. Soundings taken August 26 showed but 6 feet of water on the dam in the available channel, the stage of the river at Alton being 9 feet above low water.

In accordance with your instructions of August 31, an effort was made to lower the crest of the dam by pumping the sand from beneath it with a Roy Stone dredge. Work was begun September 13, the hydraulic excavator described in the report of the Chief of Engineers for the year ending June 30, 1882, page 1604, having been equipped with a dredge arranged as follows: The tube of three-eighths inch boiler iron was 14 inches in diameter and 40 feet long, one end of which was suspended from a derrick and the other from a davit placed on the bow of the excavator. One-half the stream from the large pump passed through a section of hose into a piece of 3-inch gas-pipe fastened to the under side of the tube and terminated with a nozzle. This discharged at the end of the tube and formed the stirring-up jet. The other half of the stream from the pump was used as an inducing current. This passed through a section of hose into a piece of 4-inch gas-pipe attached to the upper side of the tube and was divided by a fork, through the recurved legs of which it passed into nozzles inserted in the sides of the tube and pointing toward its upper end, inducing a current which raised to the surface the material stirred up by the jet.

The excavator was located about 500 feet from the Missouri shore just below the dike, on which the water was about 3 feet deep. The dredge as arranged was found to work well until the excavation had been carried to a depth of about 15 feet, when the upper end of the tube choked with sand. At a depth of about 10 feet soundings showed that sand was raised at a rate of about 1,000 cubic feet per hour. This rate, however, varied greatly with the depth. It was evident that more pressure was needed in the inducing jets, and the whole power of the pump was applied to them. The velocity of the discharge through the tube was thus greatly increased, stones of three or four pounds' weight being brought up through the tube from a depth of 15 feet, but the flow of sediment was very irregular, showing the necessity of a stirring-up jet. This was supplied by the jet of pile driver No. 3, which was anchored along side. With this arrangement excavation was carried to a depth of 27 feet. Brush found at a depth of over 20 feet located the foundation mattress of the dam, which was undermined to a distance of about 15 feet, when progress was interrupted by the falling of brush and stone into the excavation, this material, however, falling from the downstream edge of the dam without lowering its crest, which was 40 feet wide at this place.

Operations were suspended September 22, on account of the breaking of a hand-hole plate in the boiler of the excavator. A clump of piles was driven through the dike about 150 feet from the Missouri shore, just inside the best steamboat channel. This clump was used as a Government light-house.

The river continued falling, and soundings taken on the 3d of October showed but 4 feet of water in the available channel over the dam.

The work of cutting a channel through the dam by dredging was begun October 12, by the contractors, H. S. Brown & Co., of Quincy, Ill., under their proposal of October 7. Their dredge was located about 400 feet from the Missouri shore and moved in toward the bank as the dam was removed. Dredging was continued until November 9, when a channel had been excavated 385 feet wide, beginning about 15 feet from the Missouri shore. This channel had a minimum depth of 9½ feet when the gauge at Alton read 8 feet above low water. The channel was used by steamers during the balance of the low-water season, and although the river fell considerably after work was finished, no complaints were made of this locality, and it does not seem probable that more work will be required at this point.

The minimum thickness of the layer of stone removed was 4 feet, but as some of the rocks dredged up were from 2 to 4 feet long and nearly as wide and thick, this depth was exceeded in places.

The total quantity of material removed, calculated by surface measurement, was 2,451 cubic yards, of which about 25 per cent. was stone; 127.6 cubic yards of this stone was unloaded upon the dike at Alton Harbor, the remainder was dumped in the deep hole under the shore end of the dam.

A considerable quantity of brush was dredged up from the foot-mat. It was found in a very good state of preservation after being submerged for six years.

The material excavated was measured and the work inspected by Mr. Gerald Bag-nall, who displayed the same energy and ability in this as in all other duties assigned him.

Very respectfully, your obedient servant,

C. D. LAMB,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

12.

ALTON HARBOR.

REPORT OF MR. C. D. LAMB, ASSISTANT ENGINEER.

SAINT LOUIS, Mo., July 16, 1883.

MAJOR: I have the honor to submit the following report of operations at Alton Harbor during the fiscal year ending June 30, 1883.

In accordance with your letter of instructions, dated August 31, 1882, operations for improving Alton Harbor were resumed on the 4th of September.

The changes progressing in the harbor during the spring continued through the summer; the large bar at the foot of the levee moved steadily down-stream, and the scour above the dike was very marked, amounting to about 6 feet since work was begun. This scour also extended for some distance below and inside the down-stream end of the dike. The material removed seems to have been deposited in front of the tow-head below, forming a reef which is continually moving down-stream and crossing the main channel of the river against the large bar below. There had been a very marked fill below the dike, especially near the Missouri shore, where it amounted to about 12 feet.

The work done during the spring was found in good condition. The crest of the dike was from 8 to 12 feet above low water, and as the surface of the river was but 9 feet above the same plane, there was little water running over the dike, except through a few narrow depressions near shore.

The ways were found in good condition, and the construction of mattresses was begun on the 6th of September, which was as soon as a supply of brush could be procured, and continued until the 17th of November, when sixty-one mattresses had been constructed and placed. One of these mats built in position was 480 feet long, two others 100 feet each, and the remainder were each 80 feet long, all being 42 feet wide and 2½ feet thick.

These mattresses raised the dike between the points A and B to a height of about 10 feet above low water. Owing to the continued low stage of river, the method of building the dike above that height was changed by your verbal instructions, 10 feet above low water being fixed as the height of the mattress work; the dike above that stage to be built of riprap. Most of the stone received while mattresses were being built was expended in sinking them, but after the mattress work was finished the stone work progressed very rapidly, and the dike had been completed to a distance of 3,000 feet from its upper end December 7, when work was suspended on account of cold weather and running ice.

The equipment was temporarily laid up in Alton Slough until December 13, when the river became clear of ice and the stone remaining on the barges was towed to the dike and unloaded. This stone was sufficient to complete the dike for a distance of 500 feet further, but as the river had fallen about 5 feet since work was suspended, the loaded barges could not be landed within 800 feet of the lower end of the completed part. The stone was therefore placed as evenly as possible over the dike, between 3,800 feet and 4,500 feet from its upper end, raising that portion to a height of about 12 feet above low water. Four of the barges were then towed to Saint Louis, and the remainder left in the slough until December 31, when they were also towed to Saint Louis by the steamer A. A. Humphreys.

The appropriation being exhausted, no work was done at this place during the last half-year. The changes in the condition of the harbor have been continuous throughout the year; the depths at the lower part of the levee have increased from 3 to 6 feet, and the channel is much nearer shore at that place. The reef, which at the beginning of the year was opposite the water-works, has moved down below the head of Ellis Island, a distance of about 1,200 feet, crowding the channel down against

the edge of the large bar below. When work was suspended in December a strong current was running around the head of the dike into the slough, and the head of Ellis Island was being rapidly cut away by the water running through the narrow passage between it and the tow-head above, but the old dam behind Ellis Island, which is now being raised to a height of 15 feet above low water by private parties, will prevent any considerable quantity of water from passing down on the Missouri side of the island. The present condition of the harbor is shown by the accompanying tracing, Plate I.

The mattresses were built of the same size and in the same way as during previous seasons. Larger mattresses could have been handled by the boat with safety, but as, owing to the low stage of water, only about 250 cubic yards of stone could be towed to the work on each barge, and as this quantity was just sufficient to sink two mattresses, each 80 feet long, they were nearly all made of that length. The bottom tier was built as one continuous mattress for a distance of 490 feet, beginning 2,368 feet from shore. The water was but a few inches deep at this point, and the mat was built in position, the wires being attached to the bottom grillage poles before the brush was put on. The ends of the wires were held above the brush by attaching them to pegs thrust into the sand. Three other mats were afterwards built in position to close depressions in the crest of the brush work. The layer of stone used to complete the dike is 4 feet wide on top, from 15 to 20 feet wide at its base, and varies in thickness from 4 to 6 feet, being what was required to raise the top of the dike to the height of 14 feet above low water. The quantity of stone required for this purpose was considerably increased by the settling of the mattresses, which amounted to over a foot on that portion of the dike constructed during the previous year.

A section of the dike, as actually constructed, is shown in Plate—.* The shape and extent of the work done during the season is indicated by Plate—,* the mattresses placed in previous seasons being shown by red numbers. Referring to this plate, it will be seen that eight mattresses were used to fill depressions in the 2,200 linear feet of dike constructed during the previous season. Twenty-seven mattresses, each 80 feet long, and one 490 feet long, were used in extending the bottom tier to the point B. The remaining twenty-five mattresses were placed on the second tier. The top of the mattress-work was thus raised to a nearly uniform stage of 10 feet, except toward the lower end of the line, where it is about 8 feet above low water.

The brush used was procured by hired labor from Mobile Island and from the tow-head in the harbor. The larger part of the stone was procured from the Grafton Quarry Company, being loaded upon Government barges at Grafton. Owing to the scarcity of labor and other causes, only about 800 cubic yards per week were furnished. This was about the rate at which it was required for sinking mattresses, and no progress could be made in facing the top of the dike. Efforts were made early in the season to procure an additional supply of stone, but without success.

When the cutting of the brush was discontinued the force and equipment thus employed was transferred to Grafton, and the loading of stone begun from the shore below the quarry; 650 cubic yards were procured at this place, on which no royalty was paid. The force was then removed to the Illinois shore, near the foot of Piassa Island, where it remained until it was disbanded December 7, 1,550 cubic yards having been loaded, at a cost of 60 cents per yard, including a royalty of 10 cents per yard.

It was found that stone, when broken up and piled within wheeling distance of the barge, could be loaded at a cost of about 18 cents per yard.

A proposal was received from the Missouri Stone Company, and four barges were loaded at their quarry near Hop Hollow. This company can furnish stone as low as 60 cents per yard, but should other work be done in this vicinity a quarry might be leased, and stone loaded by hired labor for less than that amount.

The piling used was cut on Piassa Island and rafted to the work. The other material used was purchased in Saint Louis.

The following statement shows the amount of work done during the year and its cost:

To labor constructing and sinking 5,300 linear feet or 21,200 cubic yards of mattress.....		\$7, 379 29
To 4,534 cords brush.....	\$7, 128 26	
To 72 sticks, 1,960 feet piling.....	221 75	
To 138,174 cubic yards stone.....	14, 022 65	
To 6,000 pounds wire.....	270 00	
		21, 642 66
To equipment, steamer Little Eagle No. 2.....	2, 449 53	
To equipment, pile-drivers.....	67 20	
To equipment, skiffs.....	364 58	
To equipment, tools.....	551 57	
		3, 432 88

* Plates not forwarded.

Engineering and contingencies:

To engineering.....	\$1,230 32
To contingencies.....	314 85
	<hr/> \$1,545 17
Total	34,000 00

The number of cubic yards of brush and stone placed in the dike during the year was about 35,000, at a cost of about 97 cents per yard. About 58,700 yards of dike have been constructed since the work was begun, at a cost of \$67,324.70, or \$1.15 per yard.

This average is increased by the cost of the work done during the fall of 1881, which was \$2.90 per yard, as only 3,500 cubic yards were built on account of bad weather and rapid changes in the stage of the river.

Very respectfully, your obedient servant,

C. D. LAMB,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

13.

SUPPLY DEPOT.

REPORT OF MR. C. L. STEVENSON, SUPPLY CLERK.

UNITED STATES ENGINEER DEPOT,
Saint Louis, Mo., June 30, 1883.

SIR: I have the honor, respectfully, to submit a report of the operations at this depot for the fiscal year ending June 30, 1883.

The equipment was increased by the construction of two hulls for pile-drivers, nineteen hurdling flats, one floating machine-shop, one wharf-boat, three second-hand coal barges, converted into barge flats for carrying material, four portable shanties for telephone offices, one half section of portable shanty, three foreman's quarters, six complete sets of portable shanties for quarters.

The materials which were prepared and framed for building two new hulls for the machinery of pile-drivers No. 3 and 5 in the first half of 1882 were put together, the machinery (thoroughly repaired) was adjusted on the new hulls, and the drivers were transferred for service, No. 3 on the 6th of September, and No. 5 about the 11th of October.

The hulls are substantially built of good material, according to the general designs of those previously made here and described. The new are 7 feet longer and 2 feet broader, and the cabins 4 feet longer and 1 foot wider than the old ones, making hulls 20 feet wide, 67 feet long, 3 feet hold; cabin, 13 feet wide, 34 feet long, 8 feet high.

The dimensions of the hurdling flats are of 12, 10 feet broad, 35 feet long, 24 inches deep; of 7, 9½ feet broad, 35 feet long, 22 inches deep.

They were built, from time to time, in the first half year as they were needed, are strongly made, fastened and braced with iron.

Two of the former are decked and furnished with a boom derrick, with stiff guys, for use in constructing hurdles.

The gunwales of twenty-seven large flats were raised 6 inches, making them 22 inches deep.

To facilitate repairs to machinery by avoiding delay attending its transfer to the depot, the old hull of pile-driver No. 5 was repaired and strengthened, a cabin 14½ feet wide, 49½ feet long, 8 feet ceiling built thereon and used as a floating, movable, machine shop. It was supplied with the equipments, tools, &c., requisite for such work, and put into service about the 21st of October.

To afford easy shipment of freight, and a suitable protection to supplies intransitu in very low water—the platform of the wharf being inaccessible with ordinary means at that stage—the old hull of pile-driver No. 3 was repaired and strengthened, a cabin 17 feet broad, 48 feet long, and 8 feet ceiling built on it to be used as a wharf-boat. It was completed for service about the 16th of September.

Barge flats Nos. 41, 46, and 51 were converted into temporary mattress barges by constructing thereon platforms and ways. The platforms, similar to those on the regular mattress barges, extend 4 feet over the upper side. The ways are of oak, those of No. 41 extending 14 feet and the other two 15½ feet over the lower side to within 2 feet of the water, and are of sufficient length to weave a mattress 100 feet broad.

Ways for making narrow mattresses were built on eighteen large flats.

A new platform, 120 feet broad, extending 3½ feet over the upper side, was placed under the ways on mattress barge No. 2.

Three second-hand coal barges purchased to be altered for carrying materials were strengthened, the additions, finishing, &c., being similar to those now in use, which have been definitely described heretofore. They were fitted out each with new pumps, capstans, head and stern lines, marked United States Engineer Department, "No. 57," "58," and "59," respectively, and transferred to service Nos. 57 and 58, July 29, and No. 59, August 19.

Four portable shanties, each 12 feet long, 10 feet broad, and 8-foot ceiling, were made; three were transferred and put up, one at each of the following named places, viz, Meramec, White-house, and Ivory Station, on the Iron Mountain Railroad, for use as telephone offices for the works at Jim Smith's and Chesley Island, at Beard's Island, and at Horsetail, respectively. The fourth is here, subject to requisition.

One half section, 7½ feet long, 20 broad, and 8-foot ceiling, for sleeping quarters, was added to those on barge flat No. 28.

Three portable shanties, each 20 feet broad, 30 feet long, and 8-foot ceiling, were made and transferred to works, 2½ sections to Foster's Island, and one-half section to Chesley Island, to be put up there as foreman's quarters.

Agreeably to orders from headquarters, received about the 1st November, to construct six complete sets of portable shanties to be used as quarters in the next season, they were commenced at once, and, with their complement of furniture, were completed about the 1st of February. Each set is composed of one mess-room and kitchen, 20 feet broad, 60 feet long, 8-foot ceiling, with suitable divisions for store-room, pantry, and sleeping quarters for boarding master, cook, and waiters. One sleeping quarters, 45 feet long, and one foreman's quarters, 30 feet long, with other dimensions same as the mess-room and kitchen. Each set makes a complete outfit for seventy-two laborers, with complement of overseers and attendants.

These shanties are made in sections easily handled and put together, each set, with 306 carriage bolts. A description of similar ones, the manner of putting them together, have been described in previous reports.

One set of the sleeping and one set of the foreman's were put up on barge flat No. 48, to be used as quarters. One set of the foreman's and one section of another foreman's quarters were added to those on quarter barge No. 31.

To shut off the depot grounds from the public thoroughfare along the Iron Mountain Railroad, a board fence, 6 feet high and 521 feet long, was put up, which, connecting with the storehouses, extends from the old arsenal wall on the north to that on the south side of the depot. This line, the two walls, and the river inclose the ground occupied by the Engineer Department.

Among the smaller constructions are one hundred and seventy-eight benches, one hundred and fifty-six bunks, sixty-seven tables, ten trestles, eighteen thousand four hundred bolts, assorted; two thousand four hundred and forty-five pile stirrups, assorted sizes, and a large number of implements, tools, and appliances.

REPAIRS

which were made are described as follows, viz:

Steamer Humphreys.—In the first half of the year the wood work on the wheel was renewed, a new ice-box for transportation of perishable provisions added, a bulkhead was made to the after part of the boiler to retain heat, hold was braced on both sides, which had been damaged by ice; stanchions, steps, and boiler deck-rail repaired. In March she was drawn onto the ways, her hull overhauled, a sheet of iron plating renewed on both sides of her bow, an iron shoe put on the stern, new rivets added where needed, rudder irons repaired, plates of iron were placed under the outrigger—one on each side—to stiffen the guards, in place of old ones, which were of wood; gallows-frame knees repaired, bed-plate for capstan spindle renewed. She was calked around the stern-post, and her hull painted. The nigger engine was removed from the hold, placed and adjusted on deck.

Steamer General Gillmore.—The machinery for furnishing her with electric light was fixed in position.

Steamer Anita.—Stern-post repaired in the first half of the year. During the winter her machinery was removed to the hull of the new steamer General Gillmore, and the old hull is here, being used for the present as a wharf boat.

Launch Florence.—Purchased to be used as a tender to the engineer working parties, was raised from the water, her hull and machinery overhauled, thoroughly repaired, and hull painted. Later in the season she was again taken out, leaks in siphon and mud-pump stopped, machinery again overhauled and repaired, and a new propeller wheel, a roof, pilot-house and pilot-wheel added.

Launch Hornet.—The cabin, pilot-house, pilot-wheel, and forward deck, which were burned, were replaced by new ones. Subsequently a new rudder was made and fitted, skeg and other parts of her hull repaired.

Hydraulic excavator.—A boom derrick, crab frame, and davit were made and fitted. To increase the current of the water in the sand pump two goose-neck copper pipes were fitted, and protected under water by a basket-work of iron.

Pile-drivers.—A new set of leads and braces and one lead, one brace, and one wench-post were added, the former to No. 19 and latter to No. 21.

Slight repairs, calking, &c., were made to Nos. 1, 9, 10, and 17.

The floating machine shop was transferred to the depot on the 11th of April, since which time the machinist has been engaged in overhauling and repairing machinery to pile-drivers.

Drivers Nos. 1, 3, 6, 7, 8, 15, and 18 have been put in thorough repair. These drivers, except No. 3, are furnished with Worthington pumps, in which were used brass packing. These were found to cut easily in muddy water; to be, therefore, defective and expensive, and the pumps were altered by our machinist so as to use other less expensive and more useful packing—a description of which I will give in his words, viz:

“In working the Worthington pump it was found necessary to substitute some other packing for that used to secure at all times a full valuation of her working capacity. The original packing (a brass ring fitting the plunger and held by a gland stationary in the center of the pump, the plunger traveling through same) in pumping muddy water would cut and enlarge ring so that churning of water would occur, necessitating new rings in order to secure valuation of pump.

“Our manner of substitution is to bore out the middle partition where the original brass ring was held, fitting it in a stuffing-box and gland, the box having four turns of five-eighths inch square elastic packing. When churning commences with this packing the heads of the water-ends of the pump must be taken off and gland screwed up; not over fifteen minutes’ work.

“The elasticity of the filling insures a tight packing.

“One filling will be sufficient for a pump an entire season, doing full work, at a cost of about \$1.20—3 pounds of rubber and canvas.

“The stuffing-boxes and glands will outlast the pump.

“No. 10 driver—the first to which the improvement was applied—after being used about three months was subjected to a test of water pressure of 179 pounds to the square inch (one-third more than it was calculated to bear), and on examination of the packing it was found to be in perfect shape, thus proving the substitution to be what our service requires, a simple, easily adjusted, and inexpensive packing, comprehensive to any one.

“Since the 11th of April we have put new stuffing-boxes and glands in drivers Nos. 1, 6, 7, 8, 9, 10, 13, 15, and 18.”

Barges.—The bits, timber-heads, kevels, capstan-bed, deck, and sheathing of No. 9 were repaired, and her top sides calked all around.

Four new timber-heads, four braces, and five cross-chains were added to No. 46, her hull repaired and calked.

Four pieces of gunwales and two planks on the rake on one side, and two pieces of gunwales, one stiffener, and three rake planks on the other side of No. 53 were renewed, hull repaired and calked.

Nos. 12, 23, 32, 49, and 51 were placed in dry-dock and thoroughly repaired.

Slight repairs were made to Nos. 14, 17, 25, 27, 28, 33, 34, 38, 40, 42, 54, 57, 58, and 59.

The pumps and bitts of No. 10 were repaired, top sides, calked all around, and hull painted.

The bow of No. 13 was raised from the water with side dock, a plank below water line cut by the ice was replaced by a new one, her hull calked and painted.

Bitts, capstan-bed, deck, and hatches of No. 16 repaired, her hull calked and painted.

The pumps of No. 20 were repaired and hull painted.

The top sides of Nos. 22 and 26 were calked all around and hull painted.

Mattress-barges.—That part of the ways extending over the sides of No. 3 were repaired.

Quarter-boats.—Slight repairs were made to Nos. 2, 4, and 6. The canvas renewed in several places on the roof of Nos. 4 and 6, and roof painted.

Wharf-boat.—Slight repairs made twice during the year.

Small boats.—Yawls, skiffs, large and small flats have been overhauled, repairs made where needed. Those in service repainted, such as are not needed at present put under cover, and all re-marked “United States Engineer Department,” with their individual numbers in the respective series.

The private telephone of the Engineer Department, which puts the depot in communication with headquarters and the several engineer parties, and the city wires which connect it with the machine shops and the material and supply market in the city, have greatly facilitated operations here by enabling us to meet the wants at the works without the delay incident to ordinary means of communication.

With much respect, your obedient servant,

C. L. STEVENSON,
Supply Clerk.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

SUBSISTENCE.

REPORT OF MR. S. S. VAN NORMAN, SUBSISTENCE CLERK.

UNITED STATES ENGINEER DEPOT,
Saint Louis, July 7, 1883.

MAJOR: I have the honor to submit my report of operations in the subsistence department connected with the works of improvement under your charge, for the fiscal year ending June 30, 1883.

The present system of providing for employes under your direction was first introduced in March, 1882, and as I believe it embraces features new to many engaged on works of public improvement where large bodies of men have to be cared for, this report is made to include the time from the adoption of the system up to the end of the fiscal year.

ORGANIZATION.

(1) *Subsistence clerk.*—The subsistence clerk has special charge of the procurement and issue of subsistence supplies at Saint Louis, and regulates the bill of fare according to the season.

He also acts as special inspector of boarding masters, and visits, from time to time, the boarding houses, inspecting the boarding master's subsistence records, and the manner in which they perform their duties, reporting the result of his inspection to the officer in charge.

(2). *Boarding masters, cooks, and waiters.*—For each kitchen there is employed one boarding master at a compensation of \$60 per month, one cook at \$50, and one cook at \$30, with attendants in the proportion of one for every eighteen men provided for; the compensation of attendants being \$20 per month; all of these persons being provided with subsistence in addition to the above salaries.

The boarding masters are responsible, under the direction of the resident engineers, for the proper preparation and service of the food, for the timely procurement of supplies, for the good order and cleanliness of the sleeping quarters, mess-rooms, and kitchens, and for the preservation of the bedding, furniture, and subsistence stores.

QUARTERS.

Portable quarters, placed upon barges or on the shore, are provided, each set of which will accommodate seventy-two men and their attendants with kitchen, mess-room, and sleeping quarters.

Allowance of mess furniture for one mess-room accommodating seventy-two men.

Articles.	Quantity.	Remarks.
	<i>Number.</i>	
Basins, wash	12	
Bowls, sugar	8	
Boxes:		
Pepper	12	
Mustard	12	
Brushes:		
Scrub	4	
Dust	2	
Cellars, salt	12	
Cruets, vinegar	12	
Cups, coffee	72	
Dishes:		
Butter	8	
Gravy	8	
Vegetables	16	
Dippers, tin	4	One-pint.
Forks, table	72	
Knives, table	72	
Pitchers:		
Milk	8	
Molasses	6	
Water	4	One-gallon.
Plates:		
Dinner	80	
Soup	72	
Saucers	144	Extra saucers used for side dishes.
Spoons:		
Table	96	
Tea	80	
Towels, roller	24	Three yards each.
Tumblers	72	

Allowance of furniture for one kitchen accommodating seventy-two men.

Articles.	Quantity.	Remarks.
	<i>Number.</i>	
Ax	1	
Basin, wash	1	
Barrels, water	2	
Beater, egg	1	
Boiler:		
Waah	1	Twenty-gallon galvanized iron, with cover.
Soup	1	
Coffee	1	Twelve-gallon, with strainer and faucet.
Tea	1	Eight-gallon, with strainer and faucet.
Board:		
Waah	1	
Chopping	1	1 foot by 2 feet by 2 inches.
Molding	1	3 feet by 3 feet, with 4-inch sides and back.
Box, dredge	1	
Brooms	2	
Brushes:		
Scrub	2	
Dust	1	
Buckets, water	6	
Can, milk	1	Four-gallon.
Cleaver:		
Butcher	1	
Light	2	For chopping meat fine.
Clock, marine	1	
Cups, tin	6	
Cullenders	2	
Forks:		
Carving	2	Large.
Meat	2	Do.
Grater, bread	1	
Grater, nutmeg	1	
Griddle	1	
Hatchet	1	
Hook, ice	1	
Jars	2	Five-gallon.
Kettles:		
Camp	4	Heating water for men's washing.
Sauce	2	
Knives:		
Carving	1	10-inch.
Butcher	2	One, 8-inch; one, 12-inch.
Pallett	1	10 inches.
Mashers, potato	2	
Mill, coffee	1	
Mop	1	
Opener, can	1	
Fans:		
Bread	2	
Baking	5	
Frying	1	
Pin, rolling	1	
Plates, pie	18	
Poker, iron	1	
Pots:		
Coffee	4	One-half gallon.
Tea	4	Do.
Saw:		
Wood and buck	1	
Meat	1	24-inch.
Scales:		
Beam	1	500-pound.
Spring	1	
Scoops, tin	4	Assorted sizes.
Shovel, fire	1	
Shovel, coal	1	
Sieve, flour	1	
Skimmer	1	
Spoons, kitchen	6	Iron.
Steel, knife	1	10-inch.
Stove, cook	1	Coal, hotel superior No. 9.
Towels:		
Dish	6	One yard each.
Hand	4	Ordinary crash.
Tube, wash	3	

Allowance of bedding for seventy-two men.

Articles.	Quantity.	Remarks.
Blankets, double..... pairs..	36	
Comforts..... number..	36	
Cases, bolster..... do.....	36	
Sacks, bed, double..... do.....	36	
Sheets, double..... do.....	72	
Slips, bolsters..... do.....	36	

Two men occupy one bunk. Straw is provided for filling the bed-sacks and bolster-cases.

Single bunks are provided for the overseers, who are also allowed moss pillows in place of bolster-cases.

Resident engineers are furnished with a cot, mattress, and feather pillow each, besides the necessary allowance of blankets, sheets, and pillow-slips.

SUBSISTENCE STOREHOUSE.

This building is located at the engineer supply depot, foot of Arsenal street, about 3 miles from the central portion of the city. It is a frame structure, 25 feet wide by 125 feet long, with a cellar of the same dimensions.

The building will easily hold two months' supplies for 2,000 men.

PROCUREMENT OF SUPPLIES.

When stores are required the subsistence clerk procures proposals from the principal dealers, accompanied by samples, and then makes requisition upon the officer in charge for the articles, forwarding at the same time the proposals, with an abstract thereof, and a recommendation as to which one should be accepted.

The above applies to all subsistence stores, except fresh vegetables, which are purchased in open market, as required.

At least one month's supply of non-perishable stores is kept on hand in the subsistence storehouse.

DISTRIBUTION OF SUPPLIES.

Fresh meat and vegetables are issued semi-weekly; potatoes, flour, and butter weekly, and other supplies semi-monthly.

Requisitions from each boarding master are sent direct to the subsistence clerk three days in advance of the time the stores are required.

Invoices and receipts accompany each lot of supplies sent out.

Resident engineers sign receipts for stores received by each boarding master under their charge, and return them direct to the subsistence clerk. In addition to these duplicate receipts are made, one of which is signed by the mate of the boat on which the supplies are shipped and returned to the subsistence clerk; the other is signed by the boarding master receiving the stores and returned to the mate, who holds it as his voucher.

QUALITY OF SUPPLIES.

The quality of supplies furnished may be termed "choice." Flour is required to grade choice, and other farinaceous foods are the best the market affords.

Cured meats are of the best quality, and fresh meats the best to be had without specifying "stall-fed."

The following list of supplies provided gives detailed information as to variety and quality:

Articles.	Quality.
Apples, dried.....	Choice.
Allspice.....	Clean sifted.
Bacon, breakfast.....	Choice.
Beef.....	Best mess.
Beans.....	Choice navy.
Butter.....	Choice dairy.
Coffee.....	Prime Rio.
Crackers.....	3 X Soda boxes.
Cheese.....	Full cream.
Codfish.....	Summer cured.

Articles.	Quality.
Extract:	
Lemon.....	Price's full pinta.
Vanilla.....	Do.
Flour, wheat.....	Choice, inspected.
Grits.....	Choice and fresh in barrels.
Ginger.....	Pure ground, one-quarter pound packages.
Hominy.....	Choice and fresh in barrels.
Lard.....	Choice kettle-rendered, 20-pound buckets.
Lye.....	Concentrated, Pitts', four dozen in case.
Meal:	
Corn.....	Choice kiln dried, in barrels.
Oat.....	Choice, coarse, 2-pound packages.
Macaroni.....	Domestic, 10-pound boxes.
Mustard.....	Burrows' Lexington, half-pound tins.
Molasses, S. H.....	Belcher's.
Mackerel, No. 1.....	Half barrels, 100 pounds net.
Milk, condensed.....	Eagle brand.
Nutmegs.....	Prime sound.
Onions.....	Choice, dry.
Powders, yeast.....	Price's, 5-pound tins.
Pepper.....	Pure, ground, half-pound tins.
Pickles.....	Medium, plain, 5-gallon kegs.
Peaches, dried.....	Choice, halves.
Potatoes.....	Choice quality.
Pork.....	Choice mess, 200-pound barrels net.
Rice.....	S. C. choice and fresh.
Raisins.....	Loose muscatel.
Sugar.....	Belcher's Standard C.
Salt.....	Dairy, 10-pound bags.
Salt.....	Lake, 280-pound barrels.
Sauce, pepper.....	Half-pint bottles.
Soap.....	Best extra family.
Shoulders.....	Plain, cured.
Soda, sal.....	
Tea, oolong.....	Good medium, half chests.
Tomatoes.....	Choice, gallon cans.
Vinegar.....	Cider, forty grains.

In addition to the above, about thirteen different kinds of fresh vegetables are furnished in season.

COST OF SUBSISTENCE.

The average daily cost per man, with the average number of men subsisted daily, is given in the following table, and includes cost of service of all persons employed in connection with subsistence:

Months.	Average number of men subsisted daily.	Average daily cost per man.
1882.		
March.....	531	\$0 50
April.....	791	45
May.....	989	43
June.....	632	50
July.....	657	49
August.....	937	43
September.....	1,039	42
October.....	1,096	42
November.....	1,162	47
December.....	732	52
1883.		
March.....	281	51
April.....	462	42
May.....	382	42
June.....	192	40

* From 1st to 18th.

From the above it appears that while there were more than double the number of men subsisted during the first four months of 1882 than for the same time in 1883, the average daily cost per man in the first case was 47 cents, and in the latter only 44 cents.

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With a full working force the cost of the ration could be still further reduced, as has been demonstrated this season. In one case 68 men were subsisted one month at a cost of 35 cents per day for each man, and again 43 men were boarded for the same time at a daily cost of 37 cents per man.

The bill of fare for each day is as follows:

Day.	Breakfast.	Dinner.	Supper.
Sunday	Coffee, bread and butter, shoulder and beefsteak, potatoes.	Soup, roast beef or pork, mashed potatoes, vegetables, coffee, pudding.	Coffee or tea, bread, and butter, meat and potatoes, stewed peaches.
Monday	Coffee, bread and butter, beefsteak, boiled potatoes.	Soup, roast pork, boiled potatoes, turnips or other vegetables, pudding.	Coffee or tea, bread and butter, beef and pork, potatoes, fried or stewed.
Tuesday	Coffee, bread and butter, meat stew, boiled potatoes.	Soup (bean or rice), roast mutton, potatoes, vegetables, pie or pudding.	Coffee or tea, bread and butter, mutton and shoulder, potatoes, oatmeal or grits.
Wednesday....	Coffee, bread and butter, beefsteak, breakfast bacon or shoulder, potatoes, stewed apples.	Soup, roast beef, potatoes, tomatoes (canned or fresh), pie or pudding.	Coffee or tea, bread and butter, beef and salt meat, potatoes.
Thursday.....	Coffee, bread and butter, beefsteak, potatoes, fried or stewed.	Soup, mess beef and cabbage or other vegetables in season, potatoes, bread pudding.	Coffee or tea, bread and butter, beef (salt or fresh), potatoes, stewed apples.
Friday.....	Coffee, bread, corn-bread, butter, mackerel and beefsteak, potatoes.	Vegetable soup, codfish, potatoes, macaroni, bread or rice pudding.	Coffee or tea, bread and butter, cheese, oatmeal or grits, potatoes, stewed peaches.
Saturday	Coffee, bread and butter, beefsteak, potatoes.	Soup, salt pork and baked beans, potatoes, pudding.	Coffee or tea, bread and butter, shoulder, mush, potatoes.

The allowance of subsistence stores for one hundred men for one week, with the amounts allowed for each day, is as follows:

Articles.	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Total.
Allspice.....pounds.	.0907	.0907	.0907	.0907	.0907	.0907	.0907	.6349
Apples, dried.....do.	6				6			12
Bacon.....do.				17				17
Beef, mess.....do.	9				35			44
Beans.....do.			23				23	46
Cheese.....do.	14	9.38	9.38	9.38	9.38	9.38	9.38	70.28
Coffee.....do.						8	8	16
Codfish.....do.	6.631	4.42	4.42	4.42	4.42	4.42	4.42	33.151
Crackers.....do.						27		27
Extracts.....pints.	7	7	7	7	7	7	7	49
Flour.....pounds.	79.21	79.21	79.21	79.21	79.21	79.21	79.21	554.47
Grits.....do.	{ as required.							
Ginger.....do.								
Lard.....do.	5.5	5.5	5.5	5.5	5.5	5.5	5.5	38.5
Macaroni.....do.		5				15		20
Mackerel.....do.						20		20
Meal, corn.....do.						11	15	26
Meal, oat.....do.	as required.							
Meats, fresh.....do.	136	136	136	136	136	41	136	857
Milk, condensed.....do.	4	4	4	4	4		4	28
Molasses.....gallons.	.5	.5	.5	.5	.5	.5	.5	3.5
Mustard.....pounds.	.02	.02	.02	.02	.02	.02	.02	.14
Nutmegs.....do.	.014	.014	.014	.014	.014	.014	.014	.098
Onions.....do.	8.62	8.62	8.62	8.62	8.62	8.62	8.62	60.24
Peaches, dried.....do.	7.5		7.5			7.5		22.5
Pepper, black.....do.	.25	.25	.25	.25	.25	.25	.25	1.75
Pickles.....gallons.	.42	.42	.42	.42	.42	.42	.42	2.94
Powders, yeast.....pounds.	.67	.67	.67	.67	.67	.67	.67	4.69
Potatoes.....do.	115	115	115	115	115	115	115	805

Articles.	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Total.
Pork, mess.....pounds.....	2 5		2 5	26	2 5		26	53
Raisins.....do.....			7 45			7 45		7 5
Rice.....do.....	5	6	5	5	5	5	5	14 9
Salt.....do.....	5	5	5	5	5	5	5	25
Sauce, pepper.....bottles.....	10 58		10 58				10 58	21 74
Shoulders, smoked.....pounds.....	6	6	6	6	6	6	6	42
Soap.....do.....	23	23	23	23	23	23	23	161
Sugar.....do.....	1	1	1	1	1	1	1	7
Tea.....do.....	.67	.67	.67	.67	.67	.67	.67	4 69
Tomatoes.....cans.....	As determined	by subs	istence	clerk.				
Vegetables, fresh.....do.....	.5	.5	.5	.5	.5	.5	.5	2 5
Vinegar.....gallons.....								

The above allowance was prepared from data furnished by the subsistence records for last season, and is subject to such modification as further experience may suggest.

Very respectfully, your obedient servant,

S. S. VAN NORMAN,
Subsistence Clerk.

Maj. O. H. ERNST,
U. S. Engineers.

15.

PILE-DRIVING IN SANDY SOILS.

REPORT OF LIEUTENANT FREDERIC V. ABBOT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., April 30, 1883.

MAJOR: I have the honor to submit the following report on the subject of pile-driving, in accordance with your order of June 10, 1882, as below:

"UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., June 10, 1882.

"SIR: Having reported to me in accordance with Special Orders No. 125, Headquarters of the Army, Adjutant-General's Office, Washington, D. C., May 31, 1882, you are assigned to duty in this office.

"You are specially charged with the study of pile-driving in sandy soils. It is desired that all obtainable information on the subject be obtained, in order to ascertain whether or not the machines now in use under this office can be improved upon. In pursuing your investigations, should you desire to visit other cities or localities, you will, on application, be authorized to make the necessary journeys.

"Very respectfully, your obedient servant,

"O. H. ERNST,
Major of Engineers.

"First Lieut. F. V. ABBOT,
Corps of Engineers, U. S. A."

In accordance with the above order, I made a careful search for information on the subject; the matter in print was very slight, and what was stated was very general and unsatisfactory in its nature.

To carry out the provisions of your order it was plainly necessary to make a thorough study of the drivers under your orders, but the high stage of the Mississippi River prevented them from working under normal conditions till the middle of July.

On the 21st of that month I took up my residence at Jim Smith's, and watched the action of your drivers there at work.

The following scheme of observations was adopted at the start and continued throughout:

I took position on the roof of a pile-driver, and recorded the time at which each operation was begun and completed. The record was kept with great care, and included all epochs which were distinctly enough marked to admit of observation.

I continued these observations at different times, different stages of river, and at different places, throughout the summer and fall, till I had a sufficient number to give with considerable accuracy the relation between the different observed times. Care was exercised to insure an average result by observing in both easy and difficult situations.

In November I visited Chicago, pursuant to the above instructions, and made a similar set of observations on some drivers at work under the Illinois Central Railroad.

In accordance with verbal orders given me in the latter part of June, I have studied the probable advantages of placing more than one set of leads on a single flat, and a project for such a machine is herewith submitted.

I shall divide this report into five distinct heads.

First. The discussion and description of the action of your drivers in their present form, with suggestions upon the organization of the *personnel* to make it more efficient; also suggestions of small changes in the fittings, to render the present form of drivers more convenient.

Second. A discussion and description of the action of the form of pile-driver known as the "steam-hammer driver," employed by the Illinois Central Railroad, and a comparison of its efficiency with that of the jet drivers used by the same company, doing identical work.

Third. A consideration of the possible economy of using steam-hammer drivers in your works in place of the present form of jet drivers.

Fourth. A study of the law of variation in resistance offered to the penetration of a pile driven by a jet driver at different depths, as shown by some observations incidentally made last season.

Fifth. A project for a multiple lead driver, with discussion of the changes made in the form of leads, &c., and a consideration of the probable economy of constructing one.

PART I.—ACTION OF THE DRIVERS USED IN THE IMPROVEMENT OF THE MISSISSIPPI, BETWEEN THE ILLINOIS AND OHIO RIVERS.

MATERIAL.

Hull.—Figure 1, Plate —,* gives a general idea of these pile-drivers. The hull is 20 feet wide by about 64 feet long, and is made very stiff and rigid by two heavy, solid-built, longitudinal bulkheads; the leads are made of timbers 36 feet long, with iron on the faces worn by the hammer. The clear space between them is 20 inches. The hammer is of the usual form and weighs a ton.

Machinery.—The water for the jet is supplied by a No. 5 Worthington duplex pump, capable of discharging 165 gallons a minute, with a piston velocity of 100 feet a minute. By this pump the water is forced through a 2½-inch gas-pipe, *m, m, m, m* in the figure. This so-called *stand-pipe* terminates a few feet above the second platform in the leads, where it is coupled to a 2½ inch five-ply hose capable of supporting a pressure of 180 pounds to the square inch. This is in turn coupled to a piece of 1½-inch gas-pipe *n, n, n*, the lower end of which is connected with a piece of 1-inch gas-pipe 2½ feet long (*q*), which forms the nozzle. The reducer which connects the last two pipes is made with a square shoulder to rest on a staple driven into the pile 2 feet from its large end (the lower end), as is shown in Figures 1 and 2, Plate —.* When not in use the jet pipe stands with the nozzle resting on deck, near the leader timbers.

The hammer is permanently made fast to its line, which passes over a 15-inch sheave at the top of the leads to the drum *o*, to which it is also permanently attached. This drum (Figure 1, Plate —*) and the male friction *b* are free to slide longitudinally on the shaft *a a*; the drum also turns freely on this shaft; the male friction *b* cannot. The other male friction is permanently fast to the shaft, and is bolted to the spur-wheel *g*. The lever *c* is connected with *b* by a clutch, which allows *b* to turn with the shaft *a a*.

The action is as follows: The lever-handle *k* is nominally as far to the left (facing the leads) as it will go. In this position the drum is loose on the shaft, and the engine runs without affecting the hammer; to raise the latter, *k* is pressed strongly to the right, which forces male *b* into the female friction on that end of the drum, and slides *b* and *o* on the shaft till male *f* is pressed tightly into its female friction. The drum, being thus clamped at both ends by males turning with the shaft, must turn itself; it winds up the hammer line and raises the hammer.

When the latter is high enough *k* is moved to the left, the male frictions are thus withdrawn, the drum is freed from the shaft, the weight of the hammer uncoils the rope wound upon *o*, and strikes the pile nearly as heavily as if the fall was free, the only lessening of the blow being due to stiffness of cordage and the slight friction of the drum as it revolves on its shaft. This method leaves the height of fall and frequency of blow perfectly under the control of the master driver.

* Plate not forwarded.

The engine, a regular No. 5 Nagel agricultural engine, fifteen nominal horse-power, 12-inch stroke, 8-inch diameter of cylinder, mounted on the top of a fifteen horse-power horizontal agricultural boiler, is connected with the crab just described by a 9-inch rubber belt.

The male and female frictions are all of cast iron, and have given some trouble from wearing.

The remainder of the outfit is of the usual character, and requires no description. The anchors vary in weight from 150 to 250 pounds.

PERSONNEL.

The regular pile-driver crew is composed of:

One master driver, at \$60 a month and board.

One engineer, at \$60 a month and board.

Six deck hands, at 9 cents an hour and board.

Their duties are as follows:

1. *Master driver*.—The master driver is in charge of the entire crew, and is responsible for all the Government property on the driver. He manipulates the friction which raises the hammer, handles the log-chain line when the pile is raised from the water to be put in the leads, directs the engineer when to start and stop the pump and engine, keeps the time of his crew, keeps a record of piles driven and of the time lost in waiting for a supply of piles, and superintends placing the driver in position to drive each pile. He does this by sighting through the space between the leads, and directing the deck hands to strain or loosen the lines holding the flat till his eye is on a line with the two range flags, and is at the same instant at the proper distance from the last pile driven. Plate I shows the disposition of lines usually adopted.

2. *Engineer*.—The engineer attends to the firing of the boiler, keeps the steam at the proper pressure, runs the engine and pump, and keeps the machinery oiled and in good repair.

3. *Deck crew*.—For convenience, number these men 1, 2, 3, 4, 5, 6. While there is a difference with master drivers in the distribution of the work for the deck hands, the following is that adopted by the best masters.

No. 1 and 2.—These men are selected as being good axmen and handy with lines. They move the flat, cut the pile to the proper length, if it is not so already, sharpen it when driving in hard bottom, or in any case if the butt is more than 16 inches in diameter, and do most of the work on deck. No. 2 drives the staple which holds the jet pipe near the bottom of the pile, and he and No. 1 guide the nozzle into this staple when the pile is raised by the crew.

No. 3 and 4.—These men are on the first platform in the leads. They attend the toggle at their level, assist in raising the jet pipe, and with the assistance of 5 and 6 get the pile made fast in the leads, after it is raised by the master driver.

No. 5 and 6.—These men are on the platform above 3 and 4, and perform similar duties. In addition No. 5 frees the jet hose from kinks, and No. 6 removes and replaces the toggle which supports the hammer when aloft.

DETAILED DESCRIPTION OF THE OPERATION OF DRIVING A PILE.

Assume that a pile has just been driven, and the hammer raised to its position of rest aloft.

A temporary line is passed round the pile at *b* (see Plate —),* to hold the flat while the two bow-lines which were on pile *a* are transferred to pile *b* by Nos. 1 and 2. When this transfer has been made, the temporary line (shown dotted) is thrown off, and the flat allowed to drift down-stream about 2 feet. It is now free from pile *b* and is held entirely by lines *c* and *d*; *c* is strained, and *d* slacked off till *b* is opposite the part of the flat occupied by *a* in Plate I. Both are now equally strained till the flat can be drawn up-stream no farther by this means. The final delicate adjustment of position is now made by the stern-anchor lines, which have the leverage of the entire length of the flat and thus allow a very gradual and accurate change of the position of the center of the leads, which moves on the arc of a circle whose center is at *a* in the sketch.

While 1 and 2, under the direction of the master driver are thus at work, the rest of the crew have hauled a pile from the rear of the flat, at *e*, to a position near *f*. Here the "log-chain line" is passed round the small end of the pile (this end is up-stream), and is shifted toward the butt till it holds the pile at a point a few feet on the small end side of the center of gravity. With a well-drilled crew, this is all accomplished by the time 1 and 2 have the flat in place.

As soon as the flat is properly in position the master driver takes several turns with

* Plate not forwarded.

the log-chain line round the winch-heads at *k*, and directs the engineer to start the engine. This line, passing over a sheave at the very top of the leads, raises the pile out of the water till it hangs, *small-end* up, in front of the leads. If the pile is less than 25 feet long its top is now below the hammer (see Fig. 1, Plate —*), and it is easy to pull it back to its position between the leads. This condition of affairs is shown, in the figure. If it is more than 25 feet long the top now projects above the hammer, as shown on Plate —.*

In either case, 1 and 2 haul the bottom into place; No. 2 drives a staple 2 feet from the end to receive the nozzle of the jet pipe; this done, 1, 2, 3, 4, 5, 6 raise the jet pipe from its position of rest, and lower it; 2 guides the nozzle into the staple, and the whole is forced down till the shoulder at the end of the nozzle rests on the staple. The point of the nozzle is now 6 inches below the end of the pile, as shown in the figures above referred to.

With a short pile (25 feet and under) 3, 4, and 5, 6 now pass one end of handy lines between the leads, round the pile, and back between the leads. The other end of the handy line is permanently fastened to the leads ladder. All this is shown in the figure. When the pile is in place, the wooden toggles shown at *a* and *b* are inserted in the toggle irons, and all is ready for driving.

With a long pile (30 feet and above) the following method of handling is employed. Nos. 3 and 5 pass the handy lines round the pile as before, but Nos. 4 and 6 now take three turns with the free end round the ladder timber. The pile is of necessity supported so near the center of gravity that it assumes the position shown in dotted lines while the jet pipe is being attached.

Nos. 3 and 5 now bear all their weight on the handy lines, and 4 and 6 take in the slack as soon as 3 and 5 give it to them. In this way the pile is brought into position shown in full lines. The master driver now slacks away on the log-chain line, and the pile and jet pipe begin to settle. As soon as the butt has reached a depth of 4 feet, it is powerfully drawn down-stream by the current till it rests against the down-stream lower toggle, and this has a tendency to draw the top of the pile away from the leads. In severe currents, 3, 4, 5, and 6 have all they can do to hold it. As the pile is lowered the strain of the handy lines becomes more and more oblique till the position shown in dotted lines is reached. Here they support the pile of themselves. Nos. 3 and 4 now shift their line to its original horizontal position, 5 and 6 meanwhile holding the pile alone. As soon as the shift is complete, 5 and 6 change their line, and all proceeds as before, till the top of the pile is lower than the bottom of the hammer, when it is secured like a short pile. The pile (either long or short) is now lowered by the master driver slacking away on the log-chain line till within a few feet of the bottom; the jet pump is now started, and also the engine.

The pile is lowered till it rests on bottom, when it sinks slowly under the action of its own weight and the undermining action of the jet. The log-chain is now removed. The master driver takes hold of the friction lever (*c*), throws the friction into gear, and as soon as the hammer has been raised from its place of rest, 6 removes the rest, the engineer reverses the engine, and the hammer slowly descends to the top of the pile. A rapid descent of 8 or 10 feet in as many seconds frequently follows. When the downward motion of the pile becomes sluggish, the master driver raises and drops the hammer (which is permanently fast to the hammer line) by throwing the frictions in and out of gear. The best results in average bottom are obtainable by a quick succession of blows of between 6 inches and 1 foot.

When the pile has reached the required depth the pump is stopped, the hammer raised and toggled aloft by No. 6, and all is in the condition in which this description found it.

The above shows the operations to be performed. The time required for each is obtained from the following notes taken last summer:

* Plate not forwarded.

TABLE I.—(Observed speeds.)

Number of observation	Manipulations.			Pump.			Pile I.			Hammer.		Penetration.							Remarks.							
	Driver in position	Pile seized by chain	Pile ready to go in loads	Pile in loads	Pump starts	Pump stops	Number of strokes	Kind of pump.	Size of jet.	Length.	Diameter of bulb.	Sharp or not.	Number of blows	Maximum fall	Minimum fall	Depth of water.	2 feet.	4 feet.		6 feet.	8 feet.	10 feet.	12 feet.	14 feet.	16 feet.	Number of driver.
1	A. m. 3 27	A. m. 4 11						C.	1	52	18	Yes					24 11 15	12 00	13 20	14 00	15 00	16 00			2	Begin to sharpen at 3 ^h 37 ^m ; sharpened at 3 ^h 46 ^m ; cut off in 9 ^m . Master driver, Yeats.
2	4 30			4 56				C.	1	47	18	Yes					24 57 30	58 00	58 35	58 55	2 30	3 45	6 30		2	Begin to sharpen at 4 ^h 37 ^m ; sharpened at 4 ^h 43 ^m . Went for pile in skiff; returned to driver at 5 ^h 32 ^m . Master of driver, Joe Smider.
3	8 18			8 50				W.	1	48	10	No					28 55 15	57 15	58 00	59 50	1 55	2 55	3 30		1	
4				8 53				C.	1	47	12	No					23 54 30	55 20	55 35	55 53	56 50	59 30	0 15	1 30	2	Had to go for pile in skiff.
5	9 13			9 55				W.	1	50	13	No					23 49 35	51 10	52 50	53 05	53 25	53 35	54 00		1	Pipe came off when pile was partly down; nozzle found stopped with wood; pile finally broke off when 10 feet down.
6	9 18			9 42				C.	1	44	13	No					23 44 45	46 33	47 10	49 12	52 00				7	Begin to sharpen at 10 ^h 15 ^m ; sharpened at 10 ^h 22 ^m ; K. Co. hose, master driver.
7	10 10			10 24				W.	1	45	12	Yes					23 33 00	37 30	37 35	38 40	42 00	42 30	44 00		7	Begin to sharpen at 10 ^h 04 ^m ; sharpened at 10 ^h 08 ^m ; pile is very crooked.
8	10 00			10 15				C.	1	45	13	Yes					23 20 30	21 40	21 55	22 30	22 50	23 10	24 00		2	Begin to sharpen at 10 ^h 17 ^m ; sharpened at 10 ^h 26 ^m .
9	10 13			10 40				W.	1	48	16	Yes					23 44 00	44 15	45 50	46 30	47 30	48 30	55 00		1	Another driver in the way; delayed getting into position; had to get pile by skiff in a severe cross-current.
10	11 23			11 47				C.	1	42	14	No					22 48 10	48 34	48 47	49 15	49 50	50 45	51 30		2	

a Toggle stopped work of hammer from 4^h 59^m to 5^h 02^m.

b Pipe came off in lowering pile, having caught on toggle.

c Pipe came off pile.

d In leads second time at 10^h 22^m. Toggles catch pile going down.

e Had to cut broken head of pile in leads, it was so crushed, between 12 and 14 feet penetration.

TABLE I.—Observed epochs—Continued.

Manipulations.			Pump.				Pile I.			Hammer.			Penetration.								Remarks.				
Driver in position.	Pile seized by chain.	Pile ready to go in leads.	Pile in leads.	Pump starts.	Pump stops.	Number of strokes.	Kind of pump.	Size of jet.	Length.	Diameter of butt.	Sharp or not.	Number of blows.	Maximum fall.	Minimum fall.	Depth of water.	2 feet.	4 feet.	6 feet.	8 feet.	10 feet.		12 feet.	14 feet.	16 feet.	Number of driver.
11	h. m.	h. m.	h. m.	m. s.	m. s.	600	W.	1	45	12	No	22 54	55 05	56 15	56 40	57 40	58 50	59 35	10 25	7	Hard bottom.
12	2 17	2 28	2 41	.....	.....	.....	C.	1	47	11	No	.....	.....	.....	.....	19 55	56 20	56 30	56 45	56 50	56 50	59 00	59 10	2
13	2 17	2 30	2 36	.....	.....	582	W.	1	.....	.....	No	.....	.....	.....	.....	22 22	44 45	45 30	46 15	46 30	47 15	47 55	48 15	7
14	3 06	3 19	3 32	.....	.....	2 12	W.	1	48	12	No	.....	.....	.....	.....	22 22	42 42	42 50	43 30	43 45	44 30	45 15	45 25	2
15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	No	.....	.....	.....	.....	22 22	38 15	38 30	39 00	39 40	40 30	41 25	41 35	7
16	3 08	3 14	3 21	.....	.....	3 15	C.	1	45	13	No	.....	.....	.....	.....	23 24	24 30	25 10	25 35	25 50	26 12	26 25	26 50	2
17	8 50	9 16	9 20	.....	.....	7 15	W.	1	37	16	No	.....	.....	.....	.....	18 18	23 40	23 50	24 30	25 10	25 25	26 30	26 35	7
18	8 50	8 57	9 00	.....	.....	4 70	C.	1	38	14	No	.....	.....	.....	.....	18 18	04 43	4 58	5 30	5 45	6 00	6 05	7 00	2
19	9 46	9 56	10 03	.....	.....	4 28	C.	1	37	13	No	.....	.....	.....	.....	18 18	04 40	4 20	5 30	6 25	6 26	6 30	8 00	2
20	9 46	(/)	10 45	.....	.....	1 90	W.	1	36	13	No	.....	.....	.....	.....	18 18	45 14	45 15	45 20	45 50	46 00	46 15	46 35	7
21	10 58	11 19	11 23	.....	.....	.....	C.	1	36	16	Yes	.....	.....	.....	.....	18 18	29 40	30 15	30 20	30 50	31 15	31 45	32 40	2
22	10 58	11 23	11 28	.....	.....	2 78	W.	1	35	15	No	.....	.....	.....	.....	18 18	29 32	32 18	32 50	33 45	34 00	35 00	35 10	7
23	1 40	1 50	1 53	C.	1	35	14	No	17 17	55 56	56 40	56 55	57 20	57 55	58 20	0 50	2 55	2

1	40	1 51	1 53	W.	1 48	14	No.	17	17	06	59	15	0 20	0 35	1 35	2 50	3 30	.....	1	Start to get pile at 1 st 45 ^m .					
2	40	1 57	W.	1 35	14	No.	17	0 30	0 37	0 45	1 40A	6 00	6 35	8 30	.....	7	.....	7	.....	Passed to this driver by No. 2.			
3	35	3 50	C.	1 35	14	No.	18	55	30	55	30A	0 30	2 15	2 20	2 30	3 30	3 50	.....	2	Begin to cut off pile at 2 nd 33 ^m . Cut off at 2 nd 38 ^m , also sharpen somewhat.					
4	25	3 34	W.	1 30	14	Yes	18	44	00	46	20	46	35	47	05	47	18	48	40	Driver passed pile 30 and 31. Each transfer required about three minutes.						
5	25	3 41	W.	1 34	13	Yes	18	52	10	53	15	53	40	54	25	56	00	.....	7	Hard bottom.					
6	29	3 39	C.	1 38	13	No.	20	4 05	4 05	4 15	4 25	6 30	6 35	6 40	7 40	8 40	.....	2	Hard bottom: jet seems to have no effect whatever.						
7	30	.....	W.	1 40	10	No.	20	53	00	53	15	54	00	56	00	57	00	.....	1	Master driver is Kelly.				
8	31	4 08	W.	1 35	16	No.	20	13	45	15	20	17	00	19	00	.....	7	.....	18	Pile goes down so fast as to catch toggle.				
9	32	4 55	W.	1 43	14	No.	20	7 35	9 15	10 00	11 05A	13	00	15	00	.....	1	.....	18	(*) Hammer placed on pile.				
10	33	8 50	W.	1 22	15	No.	2	55	30	55	55	59	15	59	30	59	40	2 22	8 20	(*) Hammer on pile. (f) Begin to strike with hammer. (g) Had to stop to white: head friction, it slipped so badly.						
11	34	9 22	W.	1 22	16	No.	2	34	00	36	50	37	15	38	45	39	45	41	15	(*) Went down so fast that hammer broke: the toggle and the whole pile came out of the leads: raise and redrive as pile 42.						
12	35	10 14	W.	1 22	17	No.	2	22	30	22	30	25	06	25	05	25	55	.....	18	(*) Hammer on pile, eleven minutes wasted in getting pile property in leads.					
13	36	10 49	W.	1 24	18	No.	4	4 30	4 45	5 00m	10	12	00	16	00	.....	18	.....	18	(*) Stop to arrange toggles.				
14	37	1 43	1 53	W.	1 24	17	No.	4	54	00	55	20m	56	10	57	10	58	100	0 45	18	(*) Hammer on pile. (f) Begin to strike with hammer. (g) Had to stop to white: head friction, it slipped so badly.				
15	38	2 20	2 23	W.	1 24	17	No.	4	24	00	24	30	25	30	27	00	27	30	25	29	30	18	(*) Went down so fast that hammer broke: the toggle and the whole pile came out of the leads: raise and redrive as pile 42.		
16	39	3 20	3 38	W.	1 24	16	No.	2	38	55	39	10	39	40	40	15	41	15	41	50	43	00	18	(*) Hammer on pile, eleven minutes wasted in getting pile property in leads.	
17	40	4 47	4 54	W.	1 26	10	No.	2	55	25	55	35	55	40	56	15	56	35	57	00	57	15	57 30	18	(*) Stop to arrange toggles.	
18	41	9 56	W.	1 23	10	No.	5A	1 25	1 30	2 00*	18	(*) Hammer on pile, eleven minutes wasted in getting pile property in leads.	
19	42	10 03	10 13	W.	1 22	10	No.	5A	15	15	20	15	30*	16	20	16	50	17	10	17	30	17	40	18	(*) Hammer on pile.	
20	43	9 43	9 49	W.	1 24	15	No.	5A	25	51	10	53	00*	53	20	53	35	53	40p	18	(*) Stop to arrange toggles.	
21	44	9 43	9 49	W.	1 26	10	No.	12	50	00	50	55	51	50	52	10	52	30	57	00	18	(*) Stop to arrange toggles.	
22	45	10 00	10 00	W.	1 24	15	No.	5A	4 15	5 00	5 10	5 25	5 30	5 40	5 50	6 00	6 10	6 20	6 30	6 40	6 50	7 00	7 10	7 20	18	(*) Stop to arrange toggles.

a Jet came off pile, and the pipe was raised out of the way, jet had caught in toggle.

b Pipe came off pile. Start to get pile at 2nd 23^m. Cut off pile in leads between 2nd 25^m and 2nd 32^m.

c Belt of engine-hammer crumpled in leads outside of pile. Start for pile at 2nd 25^m; cut off between 2nd 27^m and 2nd 30^m.

d Head of pile broke off, and friction began to slip so badly that the hammer was with trouble raised.

e Kehoe got his pile jammed in the toggle and wasted 10^m.

f Start for pile at 2nd 43^m. Kehoe used too small lines to raise pile. It broke twice. He also cut pile off in wrong place, and so had to cut off again.

g So far by jet alone.

i Pipe caught in toggle. j Adjusting toggles and pipe.

k Kehoe got his line round our pile. During this delay the jet pipe got ahead of the pile as it was only lashed to the latter, thus losing most of its efficiency.

n So far by jet alone.

o Bottom slowing of speed of penetration.

p Sudden toggle came out, letting pile run too far up-stream; pull up and drive as 45.

TABLE I.—Observed epochs—Continued.

Number of observation.	Manipulations.				Pump.			Pile I.		Hammer.		Depth of water.	Penetration.							Remarks.					
	Driver in position.	Pile seized by chain.	Pile ready to go in leads.	Pile in leads.	Pump starts.	Pump stops.	Number of strokes.	Kind of pump.	Size of jet.	Length.	Diameter of butt.		Sharp or not.	Number of blows.	Maximum fall.	Minimum fall.	2 feet.	4 feet.	6 feet.		8 feet.	10 feet.	12 feet.	14 feet.	16 feet.	Number of driver.
46	10 01	.....	10 26	10 33	.....	.....	.....	W.	1	22 16	Yes	.....	.....	.....	.....	12	33 45	33 45	33 50	34 00	34 40	35 15	.....	.....	7
47	10 12	.....	10 20	10 33	32 45	49 30	10 38	W.	1½	24 18	No	.....	133	6	1	54	33 15	34 25	34 40	36 10	37 30	38 30	42 50	45 00	18
48	.....	.....	.....	1 37	39 00	43 00	2 24	W.	1	23 10	No	.....	10	5	1	54	40 15	40 35	41 30	41 32	42 15	42 35	42 40	43 00	18
49	1 58	.....	2 01	2 09	9 35	37 30	8 18	W.	1	24 18	No	.....	.....	.....	.....	6	10 40	11 40	12 35	15 10	18 45	24 10	.....	.....	18
50	3 18	.....	3 26	3 35	.....	40 50	4 49	C.	1	36 17	Yes	.....	.....	6	1	18	35 30	35 32	35 34	36 30	37 00	37 15	38 30	39 00	2
51	3 50	.....	4 05	4 10	9 45	15 25	4 58	C.	1½	38 15	No	.....	.....	.....	.....	18	10 05	10 07	10 10	10 15	12 20	12 30	13 00	14 20	2
52	4 20	.....	4 51	4 53	54 50	58 52	3 11	C.	1	38 16	Wedge.	.....	.....	4	1	18	55 30	55 35	55 40	56 15	56 35	56 55	57 30	58 30	2
53	.....	8 00	2 40	2 43	45 17	51 15	4 03	C.	1	36 18	No	.....	.....	6	1	19	45 30	46 30	46 55	47 45	49 15	51 15	.....	.....	2
54	3 00	8 00	3 10	3 13	13 20	18 25	4 10	C.	1	35 18	No	.....	.....	.....	.....	19	40 00	44 55	45 20	46 20	47 35	48 25	.....	.....	2
55	3 26	.....	3 32	3 38	39 30	44 15	3 76	C.	1	35 18	No	.....	.....	10	.....	19	40 00	40 50	41 50	43 00	44 15	.....	.....	.....	2
56	4 03	.....	4 31	4 34	35 40	39 55	3 52	C.	1	35 17	Yes	.....	.....	.....	.....	17	36 15	37 05	37 35	37 50	38 30	39 15	.....	.....	2
57	4 52	.....	4 58	5 04	5 25	12 10	5 42	C.	1	35 18	No	.....	.....	.....	.....	17	6 00	6 30	8 15	10 20	12 10	.....	.....	.....	2
58	8 43	.....	9 01	9 03	3 20	14 18	5 30	W.	1	28 14	No	.....	94	12	1	10	4 00	5 10	5 35	6 00	9 00	11 30	13 35	.....	7
59	9 19	.....	9 26	9 31	30 30	35 27	2 50	W.	1	29 13	Wedge	.....	20	4	1	10	31 30	32 00	33 00	33 20	33 45	31 20	.....	.....	7

Delay caused by sharpening.

(*) Released friction. (!) Stop hammer to adjust toggles and liges.

(*) Stopped hammer to remove toggles; Years says that piles driven without small nozzle generally go hard beyond 14 feet.

Cut off where is 10 inches in diameter in 6".

Pile goes hard; settles 1 inch per 10-foot blow; at 36 4½" chop pile to clear the head which had jammed in the leads till 36 55".

Pile was brought up wrong end up-stream; delay in turning it; cut off where 12 inches in diameter in 7" 20".

Toggles delay 1".

(*) Toggles came out, delay 2"; took a line round the pile and back to which the help toggles hold the pile. To sharpen to half wedge.

(*) Hammer on pile.

60	9 50	10 50	9 57	10 50	53 50	5 20	2 08	W.	1	28	17	Wedge	4	16	1	9	0 30	0 40	1 05	1 30	2 45	3 45	4 45	7	
61	10 53	53 00	10 57	10 56	53 53	3 53	1 07	W.	1	30	10	Wedge	45	16	8	11	50 10	50 30	0 30	0 40	0 45	0 55	1 20	3 30	
62	9 07	10 50	9 13	9 13	No pump used					28	10	Yes	86	5	3	10	15 05	15 06	16 18	17 25	30 55	23 08		10	
63	10 19	20 20	10 23	10 22	No pump used					30	11	Yes	118	8	3	13	35 45	26 55	27 45	30 30	33 50			10	
64	10 54	59 05	11 01	11 02	No pump used					29	10	Yes	83	6	3	8	5 22	5 53	*6 00	14 30	16 45			10	
65	9 46	46 10	9 47	9 50	No pump used					30	15	Yes	83	24	8	12	52 00	53 40	54 40	55 50	56 50	58 30	1 20	10	
66	10 07	8 10	10 10	10 12	No pump used					30	9	Yes	103	10	8	12	12 45	13 30	14 25	15 23	16 33	19 55		10	
67	10 26	26 20	10 27	10 29	No pump used					29	11	Yes	46	16	8	12	30 12	30 55	31 40	32 30	33 15	34 30		10	
68	10 43	44 00	10 45	10 46	No pump used					30	10	Yes	92	10	7	12	47 15	48 50	49 45	50 55	51 50	53 30		10	
69	1 37	30 50	1 41	1 46	56 50 00	94	W.			1	43	12	No	14	10	3	28	48 25	48 50	49 03	49 45	50 45	51 00		
70	1 58	0 00	2 01	2 05	25 33 30	1 27	W.			1	42	10	No	8	3	28	30 30	30 40	32 10	32 30	33 45			9	
71	2 39	40 00	2 43	3 00	00 35 4 00	5 46	W.			1	46	14	No	42	18	3	28	0 30	0 32	1 10	1 50	4 00	6 45	9 00	9
72	3 17	19 36	3 30	31 00 36 40	3 01	W.			1	48	15	No	41	20	3	28	33 00	33 30	33 50	34 45	35 00	39 00		9

a Attach rope to pile to help toggle, at 2nd 14". Belt off engine, then hammer line broke. Leave for No. 2 driver. b Hammer line parted, 20m to replace; toggle delay 14".

The abbreviations used in the above table are as follows: In column 9, C.=Cameron pump; W.=Worthington pump. In column 10, 1 inch means that the usual form of nozzle was used; 1½ inches mean that no reducer whatever was employed. In the latter case the jet pipe had no shoulder to rest on a staple, and it was consequently lashed to the pile. This caused much delay in attaching and detaching the jet.

Table II, derived directly from Table I, shows the intervals between the recorded times corresponding to the two epochs named at the head of each column. It contains only data applicable to the part of the report under present consideration.

TABLE II.—*Time intervals.*

Dimensions, &c.				Time (minutes) which may perhaps be shortened.										Time (minutes) which should be entirely avoided.						
No. of observation.	Feet driven.	Length of pile.	Diameter of butt.	Sharp or not.	Depth of water.	Gallons used in jet.	Size of nozzle.	Needed time of pile in leads to pile driven down.	To put driver in position.	Pile fast to log-chain to pile ready to go in leads.	Driver in position to pile ready to go in leads.	Pile ready to go in leads to pile in leads.	Driver in position to pile in leads.	Driver in position to log-chain fast to pile.	Delays caused by toggles.	Delays caused by jet pipes catching.	Delays caused by inefficient pile supply.	Delays caused by cutting off pile.	Delays caused by sharpening pile.	
	Ft.	Ft.	In.	Yes	Ft.	In.	Sec.													
1	12	52	18	Yes	24	1	300	14.0					43						9	9
2	14	47	18	Yes	24	1	630						26	3						6
3	14	48	10	No.	23	1	810	9.5					32				15			
4	16	47	12	No.	23	1	510	13.5												
5	14	50	13	No.	23	1	540	19.0					22			10				
6	10	44	13	No.	23	1	600	8.0					27							
7	14	45	12	Yes.	23	1	720						14	8		4				7
8	14	45	13	Yes.	23	1	540	59.0					15							4
9	14	48	16	Yes.	23	1	840						27							9
10	14	42	14	No.	22	1	270						24				7			
11	16	45	12	No.	22	1	1,225							10						
12	16	47	11	No.	19	1	490													
13	12			No.	22	1	840													
14	16	43	12	No.	22	1	735						19					6		
15	12			No.	22	1	925						24					3		
16		45	13	No.	23	1	350						13							
17	16	37	16	No.	18	1	995						30					5		
18	16	38	14	No.	18	1	420						10					3		
19	16	37	13	No.	18	1	300						17							
20	16	36	13	No.	18	1	95						59							
21	16	36	16	Yes.	18	1	586						25					7		6
22	14	35	15	No.	18	1	490						30					7		
23	16	35	14		17	1	595						13					3		
24	14	48	14		17	1	630						18							
25	14	35	14	Yes.	17	1	690						17							
26	16	35	14	No.	18	1	710						27			5				
27	16	36	14	No.	18	1	760						13			5				
28	12	34	13	Yes.	18	1	360						25							
29	16	38	13	No.	20	1	400						32							
30	10	40	10	No.	20	1	720						15							
31	8	35	16	No.	20	1	360						43							
32	12	43	14	No.	20	1	840						11							
33	14	22	15	No.	2	2	680	11.7					13	2						
34	14	22	16	No.	2	2	855	27.7					12			3				
35	14	23	17	No.	2	1	295	1.1					12							
36	12	24	18	No.	4	1	900	24.0					34							
37	14	24	17	No.	4	1	465	1.3					13							
38	14	24	17	No.	4	1	390	35.5					18							
39	16	24	16	No.	2	1	375	24.7					33							
40	16	26	10	No.	3	1	210						45							
41	6	22	10	No.	5	1	120													
42	16	22	10	No.	5	1	280	10.3					23	11						
43	12	24	15	No.	5	1	280						21							
44	12	26	10	No.	12	1	480	4.0					29							
45	14	24	15	No.	5	1	550	2.9						1						
46	12	22	16	Yes.	12	1	135						32							
47	16	24	18	No.	5	1	720						21							
48	16	22	10	No.	5	1	300													
49	12	24	18	No.	6	1	900	58.6					11							
50	16	36	17	Yes.	18	1	240	11.0					17							
51	16	38	15	No.	18	1	260	14.7					20							
52	16	38	16	Wedge	18	1	330						24			2				
53	12	36	18	No.	19	1	495											6		
54	12	35	18	No.	19	1	385	5.6					12							
55	10	35	18	No.	19	1	815	18.7					13	5				11		
56	12	35	17	Yes.	17	1	315	12.7					28					7		5
57	10	35	18	No.	17	1	490						16			1				
58	14	28	14	No.	10	1	635	5.4					20	17	2			17		

TABLE II.—Time intervals—Continued.

Dimensions, &c.							Time (minutes) which may perhaps be shortened.							Time (minutes) which should be entirely avoided.																		
No. of observation.	Feet driven.		Length of pile.		Diameter of butt.	Sharp or not.	Depth of water.	Gallons used in jet.	Size of nozzle.	Needed time of pile in leads to pile driven down.		To put driver in position.		Pile fast to log-chain to pile ready to go in leads.		Driver in position to pile ready to go in leads.		Pile ready to go in leads to pile in leads.		Driver in position to pile in leads.		Driver in position to log chain fast to pile.		Delays caused by jet pipes catching.		Delays caused by inefficient pile supply.		Delays caused by cutting off pile.		Delays caused by sharpening pile.		
	Ft.	In.	Ft.	In.			Ft.	In.		Sec.																						
58	19	29	13		Half wedge.		10	...	1	200	15.7	2	7	5		12	5														2	
59	14	28	17		Half wedge.		9	...	1	225	46.3	5	7	3		10	1															
61	16	30	9		Half wedge.		11	...	1	270	...	...	5	1		6	0														2
62	12	29	10		Yes.		10	None.	...	46.9	1	5	1		6	4																
63	10	30	16		Yes.		12	None.	...	680	78.8	2	3	1	3	1																
64	10	29	10		Yes.		8	None.	...	885	33.3	2	7	1	3	5																
65	14	30	15		Yes.		12	None.	...	680	10.7	1	1	3	4	0																
66	12	30	9		Yes.		12	None.	...	475	9.1	2	3	2	5	1																
67	12	29	11		Yes.		12	None.	...	330	11.1	1	1	2	3	0																
68	12	30	10		Yes.		12	None.	...	450	...	1	2	1	3	1																
69	14	43	12		No.		28	...	1	300	17.0	1	4	5	9	3																
70	12	42	10		No.		28	...	1	345	26.3	1	3	7	10	2	14															
71	14	46	14		No.		28	...	1	540	21.0	3	4	17	21	1	12															
72	12	48	15		No.		28	...	1	540	...	0	2	11	13	2																
Sum.	976	2,434	975		.....		1,114	...	...	37,736	526.1	27	628	295.5	1273.5	56	77.5	22	39	86	550.0										
Mean.	13.6	34.8	13.9		.....		15.5	...	...	524	15.8	1.7	11.9	5.6	17.7	8.3	1.8	0.3	0.6	1.2	0.7										

The numbers in the above table show such large variations in the time required to perform the same work under different circumstances that the means are plainly too uncertain to afford a reliable basis for estimating the absolute average time required for each. While this is the case in regard to these means as absolute values, their relative sizes afford a satisfactory means of subdividing the total time required to drive a pile, if this element be obtained from independent and more extended data. This can be obtained with great accuracy from the official records of the number of hours the drivers were at work driving and the total number of piles driven.

These figures for the last eighteen months are obtained from the following table:

TABLE III.—Eighteen months' pile record.

Locality.	No. of piles driven.	Hours driving.	Locality.	No. of piles driven.	Hours driving.
Engineer Depot	102	140	Chesley Island	382	426
Horsetail Bar	5,906	7,118	Jim Smith's	4,376	4,824
Arsenal Island	335	372	Foster's Island	66	71
Twin Hollows:			Wahoo	2,639	3,206
East side	1,611	2,033			
West side	6,330	7,375	Total	23,103	27,899
Beard's Island	1,267	1,334			

Dividing the total number of working hours in the last eighteen months (27,899) by the total number of piles (23,103), the quotient is one and twenty-one one-hundredths hours, or seventy-three minutes; this is the true average time desired.

Referring to the means obtained from Table II—

	Minutes.
The time to put driver in position is	15.8
The time from driver in position to pile in leads is	17.7
The time from pile in leads to pile driven is	8.7
Total time required per pile	42.2

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The discrepancy between the two values is to be anticipated from the following causes:

(1.) My presence made the master drivers do their very best.

(2.) I frequently noticed that drivers on which I was not present had to wait for piles to be brought to them, while those where I was located were generally kept well supplied.

To accurately distribute the cost of driving among the different operations, and thus to obtain a correct idea of the expense caused by each delay, I multiply each of the means obtained from Table II by the ratio $\frac{1}{13.2}$. The resulting product will approximate to the time actually devoted to each operation in the true average pile.

The following table shows these products:

TABLE IV.—Time required in the true average pile.

	Minutes.
Pile in leads to pile-driver.....	14.8
Pile fast to chain to pile ready to go in leads.....	2.9
Pile ready to go in leads to pile in leads.....	9.5
Driver in position to pile ready to go in leads.....	20.2
Driver in position to pile in leads.....	30.1
Driver in position to pile fast to chain.....	5.5
To put driver in position.....	26.9
Toggle delays.....	3.0
Inefficient pile supply delays.....	1.0
Jet pipe delays.....	0.5
Cutting off pile delays.....	2.0
Sharpening pile delays.....	1.2

The cost per hour of a driver and crew is approximately as follows:

Pay of master and engineer (with board).....	\$0 60
Pay of crew, six deck hands (with board).....	90
Coal and oil consumed.....	09

Total per hour..... 1 59

Multiplying the figures in the last table by 20,000 in round numbers the number driven in eighteen months, I obtain the first column of Table V.

TABLE V.—Cost per 20,000 piles—labor.

Minutes.	Hours.	Cost.	
296,000	4,933	\$7,843 47	Pile in leads to pile driven.
58,000	966	1,535 94	Pile fast to chain to pile ready to go in leads.
404,000	6,733	10,705 47	Driver in position to pile ready to go in leads.
190,000	3,166	5,033 94	Pile ready to go in leads to pile in leads.
602,000	10,033	15,952 47	Driver in position to pile in leads.
110,000	1,833	2,914 47	Driver in position to pile fast to log-chain.
538,000	8,966	14,255 94	To put driver in position.
60,000	1,000	1,590 00	Toggle delays.
20,000	333	529 47	Inefficient pile supply delays.
10,000	166	264 74	Jet pipe, delays.
40,000	666	1,058 94	Cutting off pile delays.
24,000	400	696 00	Sharpening pile delays.
2,352,000	39,195	62,320 85	To drive 20,000 piles.

The above figures refer solely to the cost of labor.

The figures in this table are exceedingly expressive; they show with clearness that any saving of time, even of a fractional part of a minute per pile, is really an important economy.

I shall now consider these items in detail and suggest all changes—first, in personnel; second, in plant—which seem to offer chances of improvement.

(1.) *Pile in leads to pile-driver.*—This time depends on two independent conditions. The nature of the bottom, depth of water, and strength of current are beyond control. They form the first condition. The second is the individual skill of the master driver and crew, both in the actual handling of the friction lever and also avoiding delays from the toggles and jet pipe.

After a pile begins to sink it rarely requires more than five minutes to sink 12 feet, unless the action of the hammer is stopped, but with most of the master drivers this is necessarily done to adjust the toggles or to free the jet pipe, as their crew is not sufficiently well trained. This time in the table is much greater than it would be with master drivers of a higher class. The absolute extent of these delays during driving I found it impossible to record, as there were no distinct epochs marking their beginning and end. Frequently the hammer was not absolutely stopped, but only lifted a few inches from the pile and the engines stopped. I estimate that about five minutes were wasted in driving most of the piles from these combined causes.

In really hard bottom to settle the pile to its full depth requires fully twelve or fifteen minutes.

(2.) *Pile fast to chain to pile ready to go in leads.*—This operation has given no trouble, and there does not seem to be any chance for improvement.

(3.) *Driver in position to pile ready to go in leads.*—This is made up of the lesser times—*driver in position to pile fast to log-chain, pile fast to chain to pile ready to go in leads*, and the time to attach the jet pipe and remove kinks from the hose. The first is five and five-tenths minutes, the second two and nine-tenths minutes, and the last must be the total time, less the sum of the other two, that is eleven and eight-tenths minutes.

The first of these three subordinate times should never occur, as only two of the crew are needed to move the flat; the other four should have selected the new pile, and made it fast to the chain long before the change of position is complete. With the best drilled crew this was always successfully accomplished.

The second subordinate time has been discussed above.

The long time required to perform the third subordinate operation was largely due to the inferior quality of staples used. They were generally unsharpened and were too soft: they often bent so badly under the blows of the maul used to drive them into the pile that two or three were tried before one was driven far enough to hold. Their failure to hold is plainly shown in the remarks to the first twenty piles in Table I.

With better staples and a master driver capable of drilling his crew well, this eleven and eight-tenths minutes should be reduced at least half. If the piles were too long, or needed sharpening for use in gravel, these delays also entered the time under present consideration. At first sight it would appear that the mean "*driver in position to pile ready to go in leads*" should equal the sum of "*driver in position to pile fast to chain*," and "*the latter to pile ready to go in leads*," but the value of the latter mean is derived from a few of the last piles recorded, and it was unobserved for the greater part of the time I was observing, while the former was observed and recorded from the outset.

(4.) *Pile ready to go in leads to pile in leads.*—This time (9.5 minutes) does not seem unreasonable when the difficulty of handling a long heavy pile, with the lower end in a strong current, is considered. It may perhaps be lessened by a new form of toggle, which, however, has not yet been sufficiently tested to justify any definite statements.

(5.) *Driver in position to pile in leads.*—This is merely the sum of several lesser times which have been discussed, each in detail.

(6.) *Driver in position to pile fast to log-chain.*—This has been fully discussed under head 3.

(7.) *To put driver in position.*—This operation demands much skill in arranging lines on the part of the master driver, and the best means of decreasing this greatest single delay seems to be the employment of a better class of masters, or in having more than one leads on the same flat.

(8.) *Toggle delays.*—These delays are particularly vexatious. They are of frequent occurrence, and are hard to avoid. When the weight of the hammer is first placed on the pile, a sudden descent of 8 or 10 feet frequently occurs, and this is exceedingly apt to jam the pile against the present form of toggles, which are rigidly held to the leads. It seems to me to be very desirable to have some form of toggle which is made fast to the pile, and is free to slide in the leads. This would leave the pile free to descend as fast as it would, and would, moreover, hold the head truly under the center of the hammer, and thus save severe strains on the leader timbers. Two forms of sliding toggles have been devised and tested. The first was of wrought iron, and proved to be much too heavy and unwieldy.

The second is made of oak, weighs only 30 pounds, and has worked very satisfactorily in strong currents; where there is little or no current there is no appreciable advantage in its use, as in that case the old form of toggles must be used at the same time.

This second form of toggle holds the pile head from moving up stream under the influence of the current against the submerged part, but has no power to resist the opposite tendency which never occurs except in nearly still water. Its construction and dimensions are plainly shown in Plate—." It also prevents any tendency of the pile to move laterally in the leads.

* Plate not forwarded.

(9.) *Inefficient pile supply.*—From the testimony of all connected with the works, this was one of the most frequent and irritating causes of delay. Piles were supplied to the drivers too long, or the supply was not kept up continuously, so that the crew often had to raft their own piles or sit and wait. During my observations such delays seldom occurred on the drivers when I was present, but I have often noticed others waiting idle, for more piles. A well-organized force to cut up the original pile rafts, and sort the piles, and another, or, better still, a steam launch, to tow the piles to each driver cut to exactly the proper length for its use should exist wherever pile driving on a large scale is in progress.

(10.) *Jet pipe delays.*—These are principally due to defective staples, which fail to hold the jet pipe to the pile, and to the square joint where the flexible hose joins the jet pipe proper. This shoulder is liable to catch on the platforms as the pile and pipe descend, and not infrequently raises the nozzle out of the staple. Sufficient care on the part of the leader boys is all that is required to prevent this. A coupling with a beveled edge in place of the square shoulder would, if not too expensive, be of great advantage.

(11.) *Cutting pile off.*—This would be avoided entirely by supplying the drivers with piles already of the proper length.

(12.) *Sharpening piles.*—With jet drivers this is seldom required. It is necessary when the bottom is clay or gravel, and when the butt is over 16 inches in diameter, and cut off square.

A half wedge with the jet pipe stapled to the side on which the wedge is cut, seems to be as efficient usually as a sharp point. The pile in this case sinks vertically. The pile can best be sharpened on the driver, as to do this easily the log has to be raised out of the water. To sharpen to a half wedge requires only between two and three minutes.

PAY AND CREW.

Study of the subject has led me to think that the organization of the crew, already described, admits of no improvement, but there is great need of some incentive to the master driver to do more work. That fifteen piles a day were driven when I was present and nine or ten when I was not is suggestive; and it seems to me that there is great evidence of a general tacit understanding among the masters that ten piles a day was to be the number considered as an average day's work, and that so long as no one exceeded that limit no one would be compelled to do so. This is indicated in many ways.

Several of the masters drove over twenty piles in a single day, when their average for the month had been so poor that they were threatened with discharge if they did no better. One who seemed to be independent of such combination averaged for the entire summer much above ten, and one day in an easy place drove thirty-five piles. Another suggestive fact is the unnatural uniformity of the rate of driving in easy and hard situations. That two drivers, one working in deep, swift water, the other in shallow and slack, should make the same average is significant, and that this uniformity does exist is at once seen by examining the official pile-record book.

Accepting some such understanding as a probable fact, the first necessity of good work is to break it up.

During the last eighteen months the masters have been paid by the month, and so long as they drove enough piles a day to retain their situations they had no inducement to overwork themselves.

The evident advantage of the system is that there is no temptation to make a large record by underdriving the piles, but the danger is that this desirable end may be more than balanced by the indifference of the master drivers about making rapid progress.

For the coming season I should recommend the following scale of pay, the object of which is to induce the masters to work hard by allowing their work over a certain number of piles to increase their pay.

The rate for a master driver to be \$75, subsistence included. For this pay a monthly average of fifteen piles for every ten hours' work during the month is required. At the end of each month the total number of hours each master has worked is to be multiplied by fifteen and the result divided by ten. The result is the number of piles he should have driven to make the average fifteen. If he has driven more than this he is to receive 10 cents for each pile in excess. If less, he is to forfeit 20 cents for each pile he is short. If any master falls below an average of twelve piles he should be discharged. These numbers are given only as a standard. In very deep water, where the bottom is gravel or clay, there is no question but what fifteen piles is too much to expect of the most skillful master. The resident engineer, therefore, in making up the time-roll should state the number of piles driven by each master, and if the number falls below that required he should state whether in his judgment it was through the fault of the master or from the class of work he had been doing. In easy

positions the fifteen average should be twenty. All this must of necessity be left to the judgment of the resident engineer, who is on the spot. Otherwise great injustice could easily result from the system.

To form a clear idea of the relative cost of driving by last season's and by the proposed systems, the following examples are taken:

First. Assume that the average 15 is just attained:

Cost of driver and crew for 10 hours = \$15.90.

The average cost per pile is therefore $1\frac{1}{2} \times 1.06$ (subsistence included).

At last season's rate, to drive fifteen piles takes fifteen hours; the cost per pile is therefore $1.59 \times 1\frac{1}{2}$ = \$1.59.

A saving of \$1.59 - \$1.06 is made = \$0.53 per pile.

Each pile in excess of fifteen costs only 10 cents, as it takes no extra time of driver and crew. A clear saving is thus made of \$1.59 (the cost per pile last year), diminished by \$0.10 = \$1.49.

The temptation to drive the piles to less than the required depth is great under the new system, and it seems advisable to employ an additional resident engineer at each work at which four or more drivers are employed, whose sole duty it is to watch the drivers, to organize and maintain an efficient force to supply the piles of the exact length to be used by each driver, and to keep the pile-record book. One of the resident engineers who has been on the work a year would make a much more efficient inspector than a new man would, and his place might be filled by a recent graduate from some engineering school, at the rate of \$75 a month, subsistence included.

This sum, deducted from the saving made by the increased number of piles above assumed, gives the following results:

Assuming four drivers at work:

Number of piles driven a day = 60.

Daily pay of new resident engineer (subsistence included) = \$3.00.

Cost of inspector per pile = $\frac{3.00}{60}$ = \$0.05.

The saving is then \$0.53 - \$0.05 = \$0.48 per pile.

Piles in excess of fifteen evidently increase the economy much, and examination shows that the deduction of 20 cents for a less number than fifteen also creates a saving over last year's ratio. It seems, therefore, that the result of applying the new system must be a considerable saving in money, and the pile inspector can keep very valuable records, which are difficult to obtain unless some one of that class is available for the purpose.

CHANGES IN PLANT.

With a view to determining the value of volume of water as compared with the velocity with which it issues from the nozzle, in the jet driving, I tried the experiment of driving a number of piles with no reducing nozzle at all. These are shown in Table I, in the column marked "Size of nozzle," by having a nozzle orifice of $1\frac{1}{2}$ inches. The effect, if any, seemed to be a slight increase in the speed of descent for the first 10 or 12 feet, followed by very hard driving. The rapidity at first was perhaps due to the large volume of water used, the hard driving to the nozzle being clogged from insufficiency of velocity to clear itself. To further test this point, I should recommend that one or two drivers be supplied with a jet pipe 2 inches in diameter, with two nozzles of the form shown on plate;* one with the orifice 1 inch, the other $1\frac{1}{2}$ inches in diameter. The question could then be definitely set at rest, and the expense would be slight.

Second. The form of reducer now in use seems to be capable of great improvement, as shown in Plate —.* One of these tapering nozzles was made by the regular blacksmith, and has given great satisfaction.

Third. The coupling between the jet pipe and hose should be made without the square shoulders it now has. These are continually catching on platforms and toggles.

Fourth. The rest which supports the hammer when aloft should be operated from the deck as shown in Plate —.*

Fifth. There should be, as shown on Plate —* a hinged portion of the upper part of the walls of the engine house, which could be opened in warm weather to allow the superheated air to escape. This would contribute immensely to the health and comfort of the engineers.

Sixth. There should be a chock placed in the window in the rear of the engine-house to save wear on the down-stream anchor lines when they are led to the steam winch.

Seventh. For some reasons it appears at first sight as though there would be great advantages in having the leads on the side of the flat, instead of on the end. By this

* Plate not forwarded.

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means the flat always overlaps at least two piles already driven, which assists materially in alignment, but when such a large proportion of the work is done directly across strong currents the disadvantage of exposing the long side of the flat to the force of the water overbalances the advantage gained.

A complicated arrangement to preserve the trim of the flat is necessary when the leads are on the side. At Plum Point, where this kind of driver is employed, it has been found necessary to employ drivers with leads at the end to close gaps, and this of itself condemns the system, as it is very inconvenient to have two different forms of driver at work together, especially when one form is incapable of completing its own work.

PART II.—ACTION OF THE DRIVERS USED IN THE LAKE SHORE PROTECTION AT CHICAGO, ILLINOIS.

Through the kindness of Mr. E. T. Jeffery, general superintendent of the Illinois Central Railroad, I was enabled to watch the drivers which that company are using in protecting the lake front of their Chicago property against the inroads of the lake, and to copy both the records and the drawings relating to pile-driving which they have preserved.

I wish to express here my appreciation of the uniform courtesy with which I was treated by all persons connected with this company, and of the many and unusual facilities for making personal investigations and obtaining access to the official files of records and detailed drawings afforded me by Mr. H. A. Kennedy, the master carpenter of the railroad, and Mr. Renshaw, the master machinist of their shops at Weldon.

The company had three drivers—numbered 1, 2, 3—at work all last season. No. 1 was a steam-hammer driver; Nos. 2 and 3, jet drivers of the usual form.

MATERIAL.

No. 1. Hull.—The hull is 46 feet long by 24 feet wide by 5 feet deep and is stoutly made and bulkheaded. This has been found to be too short to be used to advantage in pulling old piles.

The leads are of the usual form and height. The weight of hammer is so great, that its line after passing over a sheave at the top of the leads ends in a single block. The line from the power-drum passes under a snatch-block at the foot of the leads ladder, up parallel to the ladder, through the block on the end of the hammer line, and down again to a strong staple in the deck of the flat.

No. 1. Machinery.—There is no water jet used with the driver. The hammer is raised and lowered, and the flat moved and piles handled by a twenty-horse power double-cylinder engine with a horizontal boiler. For detail see Plate —.*

The engine was built in 1871. The boiler carries 120 pounds of steam; it has been found to be somewhat too small; the steam-dome is likewise too small to work dry steam, and the result is great loss of fuel, as the supply pump is kept at work forcing cold water into the boiler all the time the engine is at work.

The hammer-drum is coupled to the shaft at will by a gun-metal clutch. See Plate —.*

This is never done while the engine is in motion, the only object of the clutch being to allow the engine to run the winch-heads without disturbing the hammer. The engine is capable of reversing very quickly and easily.

The peculiar feature of the driver is the hammer (plate).* It is composed of two I beams (iron), which form the frame of the whole machine, the leaders for the weight to work in, and at the same time the slides which retain the whole in its position between the wooden leaders of the driver. They are held together at the base by a piece of cast iron, *a*. This is really a hollow frustum of a cone the upper base of the conical opening being 11 inches in diameter, the lower base 15 inches. The top of the pile, “*z*,” is cut to a conical shape to fit this opening, and to project into it till the end of the pile is nearly on a level with the upper surface *y*.

The tops of the I beams are fastened directly to the steam cylinder *b*. The weight or hammer proper, *c*, weighs 2,000 pounds.

The action of the machine is as follows:

The pile is raised into its position by the winch-engine; is lowered till it rests on bottom, and is there held by men in the leads. The hammer-drum is now (the engine having stopped) coupled to the shaft by its clutch (Plate —),* the engine started, and the hammer raised an inch or so, one of the deck-hands pulls down on rope “*z*” (see

* Plate not forwarded.

Plate),* thus removing the hammer support. The engine is reversed, and the hammer slowly lowered till the conical top of the pile is fully engaged in the conical cavity in piece *a* (plate*). The top of the pile is thus held perfectly firm and centered in the leads.

The weight *c* is now supported on the head of the pile at *p* by the cylindrical portion *a*, which projects 6 inches below the main body *c*. All is then in condition shown on the plate.

Steam is admitted through the hose *H*. It passes through the valve *d* into the lower end of the cylinder, and raises the hammer *c* till the inclined plane *e* moves the valve-cam *f*.

This admits steam to an auxiliary cylinder *d* (the valve cylinder), where it presses on the bottom of a peculiar form of D-valve, which it forces to the upper end of the auxiliary cylinder.

The motion of the D-valve cuts off the supply of steam from the bottom of the main cylinder, and opens a very large exhaust port at the same time. No steam is admitted to the upper end of the large cylinder at any time.

The weight of the hammer *c* causes it to fall, drawing the piston-rod and piston down with it. The cylindrical portion *a* strikes the top of the pile *p* and drives the latter down; as soon as the pile begins to sink, the whole frame (hammer cylinder and I beams) is left unsupported and follow it up. When in the fall of *c* the cam lever *f* released *e*, the latter moved back to the position shown in the plate, and steam is thus cut off from the auxiliary cylinder, at the same instant a connection through the pipe *g* is made between the two ends of this cylinder. This allows the steam which held the D-valve at the upper end of *d* to press on both top and bottom of the sliding valve. The rate of the latter's fall is so regulated by the cock *h*, which determines the speed of admission of steam to the upper end that the steam is admitted to the lower end of the main cylinder just after the weight *c* has fully delivered its blow. The whole operation is now repeated.

The cock *h* makes it possible to adjust the machine to strike any number of blows a minute, up to eighty. Further, simple adjustments allow the length of stroke to be varied, as well as the force of the blow. This is done by admitting steam to the main cylinder early enough to furnish a steam cushion.

The efficiency of the machine will be fully discussed later.

Nos. 2 and 3. Hull.—These drivers are twins. They are on hulls 46x24x5 feet; the leads are in all respects very similar to those in use under this office, the main difference being that the hammer line is led down under the ladder, round an idle sheave, and thence to the friction-drum.

Nos. 2 and 3. Machinery.—A double-cylinder engine mounted with an upright boiler supplies the power; the water for the jet is supplied by a Nye-pump. Experience with the latter has led to its rejection by the Illinois Central Railroad. It fails to give sufficient pressure to form an efficient jet.

The main difference between these drivers and those under this office is in the form of friction gearing used to raise and drop the hammer. Plate —* gives a general idea of the engine, boiler, and frictions.

This compact arrangement of engine, boiler, and crab on one iron bed plate makes it easy for one man to attend both engine and hammer, and thus do the work of two; the vertical boiler is regarded as objectionable.

In the position shown in the figure, the engine is running under full steam, and the drum is clamped to the shaft, as when raising the hammer. When the latter is at the proper height for the blow desired, handle *a* is moved upward and toward the boiler, handle *b* to a horizontal position, both as indicated by arrows in the figure; *a* releases the friction coupling and lets the hammer fall, *b* shuts off steam from the engine.

In use *a* is held in the master driver's right hand, *b* in his left. A general motion of leaning forward thus starts the engine, and clamps the drum; straightening up drops the hammer and stops the engine; the force applied at *a* to raise 3,600 pounds hammer is slight. By using a double-cylinder engine there is no delay in starting, and steam is used only in doing useful work.

Plate —* shows the details of the friction coupling. The crab consists of a shaft *a* running in the journals *b*, which prevent motion in the direction of the axis of the shaft. A spur-wheel *c* interlocking with a power pinion on the engine shaft, is keyed permanently to "a"; to its face are bolted five oak segments, saturated with some preservative and lubricating preparation. These segments are so attached as to have the grain run radially; their outer ends are returned to a frustum of a cone, and form the male friction surface *d*. The drum *e* and the female friction-surface *f* are cast in one piece, and the whole turns freely on shaft *a*. A spiral spring *g* is employed to hold the male and female surfaces apart, when not intentionally pressed together. A

* Plate not forwarded.

mortise *h* is cut through the shaft at the end of the drum farthest from the female, and through this a plate, *i*, is placed, and held by pins so that it is free to slide in the direction of the shaft axis, but has no other motion with respect to the shaft.

This plate, *i*, bears against a washer, and the latter rests against the end of the drum *j*. A cylindrical hole is bored through the shaft from its end *k*, to the bottom of the mortise in which *i* slides; a bolt, *m*, passes through a stationary nut, *n*, shown also in figure, — at *n*. For 6 inches from its point the thread is turned off, and this portion is inserted in the hole in the shaft, till the point touches "*i*." The action is now plain. Turning the bolt "*m*" to the right forces it to advance toward the drum; this makes the cylindrical part penetrate more deeply into the cylindrical hole in the shaft, and as the point of *m* touches *i*, it forces the latter against the drum, and the latter against the spiral spring *g*, which is thus compressed. The male enters the female and as the motion of *m* is continued the two friction surfaces are pressed so tightly together that the drum is held as firmly to the shaft as if it was keyed. Turning *m* to the left now reverses the entire operation, and the drum is once more loose on the shaft.

The screw-thread on *m* has such a pitch that a movement of 50 degrees is all that is needed to clamp the drum.

The action is perfectly under control at all times, so much so that I have seen the hammer held stationary in the leads, without stopping the engine, by simply lessening the pressure on *a* just enough to let the two friction surfaces slide on each other with the proper relative velocity.

Nos. 1, 2, 3. *Minor details.*—All the hammer rests are placed and removed from deck in the manner shown in Plate —."

All the chocks have the jaws iron-covered (Plate —),* and are provided with an inch chain about 2 feet long, very firmly stapled to the body of the chock. They are used as follows: A line is led through the chock to the winch, and strained till the flat is in the desired position; a half-hitch is now taken around the line with the chain, and the line thrown off the winch. The strain draws line and chain into the jaws of the chocks, and jams them so that there is no further motion. To free the line it is put to the winch again, and the strain frees the chain from the chock, and all the slack desired is taken in, the line is again thrown off the winch, and is at once held by the chain as before. It would seem that this treatment would be very severe on the lines, but all concurred in the statement that, according to experience at Chicago, lines lasted as long with chain stopping as with ordinary cavils.

PERSONNEL.

The Chicago crew is constituted as follows:

	Per day of 10 hours.
1 foreman of driver	\$3 00
2 leader men	each.. 2 75
1 loft man	2 50
1 engineer	3 00
1 fireman	2 00
2 deck hands	each.. 2 00
1 axeman	2 00
Total, nine men	17 25

On the drivers while I watched them the engineer handled the hammer as well as the engine, and the foreman was in charge of all three drivers. Two of the crew were at work all the time on the flat loaded with piles, where they were engaged in trimming them to a true conical head to fit the cone in the bottom of the steam hammer, and in removing the bark. According to Mr. Kennedy there has been great difficulty in getting men capable of running the steam-hammer driver up to its real capacity.

NATURE OF WORK.

All three drivers were at work on an extensive shore protection, which consists of two rows of piles (oak) bolted to oak waling pieces. In each row the piles are driven in contact; the clear place between rows is 6 feet. This space is filled in with very large riprap, and the two rows connected together by tie-bolts, 10 feet apart, which pass through the stone at the level of the waling pieces.

* Plate not forwarded.

In 10 feet of water the following material is used in each 100 linear feet:

Piles.....	140
$\frac{3}{4}$ -inch bolts (average length, 24 inches).....	100
4 by 4 by $\frac{1}{2}$ inch washers.....	200
1 $\frac{1}{2}$ -inch rods 9 $\frac{1}{2}$ feet long, with head and nut.....	20
6 by 6 by $\frac{3}{4}$ inch washers for the above.....	40
6 inches by 12 inches by 20 feet oak waling pieces.....	10
Cubic yards riprap stone.....	222

The bottom is moderately coarse sand, free from large stones, and with little or no clay to bind it together. At times the driving was done where old pile work or cribs have been formerly placed, and this is the reason of the very small number of piles driven on some days.

There was a feeling of great rivalry between the different master drivers, especially between the jet and steam-hammer men, and these two forms thus received as fine a comparison of their inherent merits as it is possible to obtain where so much of the efficiency of the plant depends on the energy and skill of those who handle it.

The following table, copied from the official records in Mr. Kennedy's office, shows the work done by each driver from August 21 to November 13, 1882, both inclusive:

TABLE VI.—Chicago pile record.

Date.	Driver No. 1.				Driver No. 2.				Driver No. 3.			
	No. of piles driven.	Depth driven.	Feet.	Locality.	No. of piles driven.	Depth driven.	Feet.	Locality.	No. of piles driven.	Depth driven.	Feet.	Locality.
Aug. 31	11	14	4	Forty-third street	53	14	8	Kenwood street				
22	44	14	4	do	94	14	8	do	7	14	8	Kenwood street.
23	67	14	2-6	do	45	14	5-10	do	33	14	4-6	Do.
24	52	14	2-3	Thirty-seventh street	29	14	9	Oakland street	25	14	10	Do.
*25												
26	74	14	10	Thirty-fifth street	66	14	10	Kenwood street				
*28												
*29												
*30												
Sept. 1	12	14	9	Thirty-fifth street	18	14	2	Oakland street	22	14	2	Oakland street.
*2	4											
4	62	14	9	Thirty-fifth street	30	14	2	Oakland street	51	14	10	Kenwood street.
*5												
6	44	14	9	Thirty-fifth street	41	14	2	Oakland street				
7	98	14	9	do	82	14	2	do				
8	98	14	9	do	115	14	4	do	71	14	10	Forty-fifth street.
9	8	14	9	do	1	14	4	do	1	14	10	Do.
*11												
*12												
*13												
14	22	14	9	Thirty-fifth street	37	14	4	Oakland street	30	14	10	Forty-fifth street.
15	91	14	9	do	104	14	4	do	79	14	10	Do.
16												
18	37	14	9		38	14	4	Oakland street	41	14	10	Forty-fifth street.
19	99	14	9	Thirty-fifth street	73	14	4	do	93	14	10	Do.
20	105	14	9	do	115	14	4	Forty-third street	74	14	6	Forty-first street.
*21												
*22												
23	45	14	9	Thirty-fifth street	30	14	4	Forty-third street	28	14	6	Forty-first street.
24	34	14	9	do	9	14	4	do	8	14	6	Do.
*26												
*27												
*28												
*29												
*30												
*Oct. 1												
*2												

3	118	14	9	Thirty-fifth street	57	14	4	Forty-first street	14	6	Forty-first street	6	Forty-first street
4	101	14	9	do	87	14	4	Forty-third street	14	6	Do.	6	Do.
6	90	14	9	do	102	14	6	Forty-first street	14	6	Do.	6	Do.
7	66	14	9	do	89	14	6	Forty-first street	14	6	Do.	6	Do.
9	11	14	9	do	113	14	4	Forty-third street	14	6	Forty-first street	6	Forty-first street
10	13	14	9	do	116	14	4	do	14	6	Do.	6	Do.
11	13	14	9	do	116	14	4	do	14	6	Do.	6	Do.
12	13	14	9	do	116	14	4	do	14	6	Do.	6	Do.
13	13	14	9	do	116	14	4	do	14	6	Do.	6	Do.
14	88	14	9	Thirty-fifth street	113	14	4	Forty-third street	14	6	Forty-first street	6	Forty-first street
15	84	14	9	do	116	14	4	do	14	6	Do.	6	Do.
16	16	14	9	do	116	14	4	do	14	6	Do.	6	Do.
17	16	14	9	do	116	14	4	do	14	6	Do.	6	Do.
18	10	20	6	Round House	116	14	4	do	14	6	Do.	6	Do.
19	23	20	6	do	116	14	4	do	14	6	Do.	6	Do.
20	57	20	6	do	116	14	4	do	14	6	Do.	6	Do.
21	8	20	6	do	116	14	4	do	14	6	Do.	6	Do.
22	21	20	6	do	116	14	4	do	14	6	Do.	6	Do.
23	18	20	6	do	116	14	4	do	14	6	Do.	6	Do.
24	46	20	6	Round House	116	14	4	do	14	6	Do.	6	Do.
25	26	14	9	Thirty-fifth street	80	14	6	Forty-first street	14	6	Forty-first street	6	Forty-first street
26	37	14	9	do	23	14	6	do	14	6	Do.	6	Do.
27	39	20	6	Round House	23	14	6	do	14	6	Do.	6	Do.
28	28	20	6	do	23	14	6	do	14	6	Do.	6	Do.
29	20	20	6	do	23	14	6	do	14	6	Do.	6	Do.
30	20	20	6	do	23	14	6	do	14	6	Do.	6	Do.
31	77	14	9	Thirty-fifth street	80	14	6	Forty-first street	14	6	Forty-first street	6	Forty-first street
Nov. 1	77	14	9	Thirty-fifth street	80	14	6	Forty-first street	14	6	Forty-first street	6	Forty-first street
2	3	14	9	do	80	14	6	Forty-first street	14	6	Forty-first street	6	Forty-first street
3	3	14	9	do	80	14	6	Forty-first street	14	6	Forty-first street	6	Forty-first street
4	3	14	9	do	80	14	6	Forty-first street	14	6	Forty-first street	6	Forty-first street
5	3	14	9	do	80	14	6	Forty-first street	14	6	Forty-first street	6	Forty-first street
6	75	14	9	Thirty-fifth street	74	14	13	Twentieth street	14	13	Forty-third street	4	Forty-third street
8	3	14	9	do	102	14	13	do	14	13	Twentieth street	13	Twentieth street
9	43	14	9	Thirty-fifth street	67	14	13	do	14	13	Do.	13	Do.
10	65	14	9	do	66	14	13	do	14	13	Do.	13	Do.
11	65	14	9	do	66	14	13	do	14	13	Do.	13	Do.
12	65	14	9	do	67	14	13	do	14	13	Do.	13	Do.
13	65	14	9	do	67	14	13	do	14	13	Do.	13	Do.

† Broke down.

* Stormy.

1270 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

The mean number of piles driven in a day by the different drivers are: No. 1, 53.9; No. 2, 66.9; No. 3, 54.4. Nos. 2 and 3 drove some piles in the round-house, which are not recorded. There each pile had to be in exact position, within an error of 6 inches, and was required to be driven 20 feet.

For this work No. 1 was the most efficient, and did a large part of the work. The work was of such a difficult character that it should not be considered with the rest in comparing the two forms of driver. Omitting those days on which No. 1 worked in the round-house (Nos. 2 and 3 being unrecorded when at work there), the following are the means which afford a true comparison: No. 1, 63.2; No. 2, 66.9; No. 3, 54.4 piles a day. The figures speak for themselves. There is little or no advantage in the complicated machinery of the steam hammer. Its average is less than one and greater than the other of two twin jet drivers, which were doing identical work alongside of it.

OPINIONS OF MR. H. A. KENNEDY AND OTHERS.

"The jet drivers on the long average do as much or more than the steam hammer, and this in the class of work now under execution here (Chicago), where the machine-shops of the company are available at any instant.

"The leads last between three and four times as long with the steam hammer as with the drop hammer. A hammer line lasts the steam hammer one month, while it needs replacing about once in five days with the other form. Say it will drive 500 piles on a jet, 3,000 on the steam hammer driver. The flats for both are too broad and short for convenience in pulling old piles.

"The steam hammer leaves the pile-head as good as it was before driving, while the jet drivers injure the head to a considerable extent. On this account, in contracts for wharf work, it is not infrequently stipulated that all piles be driven by steam hammering. For work at a distance from machine-strokes the steam hammer is liable to cause great delays from breakage of some part, and for such work jet drivers are immensely preferred. On a car in land driving the steam hammer is immeasurably superior, as there is much less jar, and the water needed is not excessive. Sixty-five piles a day are expected of every driver in the lake shore protection; if less are driven the matter is looked into. Hard bottom is liable to reduce this number very largely."

Time record.—Bad weather prevented me from seeing the jet drivers at work, except for a part of one morning, in the round-house; here the jet was not used, the tendency of a jetted pile to move laterally in driving prohibiting its use there.

The following observations were made, under average conditions of wind and waves, on the steam hammer:

TABLE VII.—Steam-hammer observations.

Number of observation.	Driver in position.	Pile in leads.	Hammer on pile.	Start hammer.	Pile driven.	No. of strokes.	Hammer aloft.	Depth of water.	Length of pile.
	m. s.	m. s.	m. s.	m. s.	m. s.		m. s.	Feet.	Feet.
73	24 10	25 20	25 40	25 48	27 30	84		7	24
74	29 20	30 30	31 00	31 55	32 55		33 30	7	24
75	35 30	36 30	37 20	37 40	39 45	104	40 15	7	24
76	40 45	41 40	42 05	42 20	43 45	63	44 10	7	24
77	44 55	45 30	46 25	46 45	48 10	66	48 30	7	24
78	49 30	50 30	51 00	51 05	54 05	155	54 30	7	24
79	57 55	59 00	59 20	59 50	2 00	129	2 25	7	24
80	3 30	4 30	4 55	5 10	6 40	88	7 20	7	24
81	8 15	9 05	9 40	9 52	11 05	75	11 30	7	24
82	12 20	13 30	14 05	14 12	15 35	79	16 00	7	24
83	17 10	18 40	19 15	19 27	20 50	172	21 15	7	24
84	22 30	25 30	26 20	26 45	29 35	128	30 10	7	24
85	34 45	39 15	39 45	39 55	41 10	72	41 35	7	24
86	42 15	44 15	44 55	45 13	46 40	85	47 05	7	24
87	48 00	49 15	49 35	49 50	52 15	122	52 40	7	24
88	54 00	54 55	55 25	55 30	57 10	77	57 45	7	24
89	58 35	0 05	0 35	0 48	2 50	80	3 15	7	24
90	4 00	5 10	5 40	5 40	7 80	76	7 55	7	24
91	9 00	10 00	10 25	10 42	12 50	60	13 15	7	24
92	19 00	20 15	20 55	21 10	23 10	80	23 35	7	24
93	24 20	25 55	26 30	26 53	29 00	72	29 25	7	24
94	31 30	32 00	32 15	32 25	33 55	69	34 40	7	24
95	27 00	28 30	29 05	29 25	31 10	75	31 35	7	24
96	34 35	35 55	36 10	36 33	37 05	30	37 30	7	24
97	35 20	39 20	39 40	39 52	40 20	25	40 45	7	24
98	41 25	42 22	42 45	43 03	43 23	26	43 55	7	24
99	44 50	45 35	46 10	46 25	46 59	81	47 35	7	24
100	48 25	49 35	50 05	50 20	51 12	42	52 10	7	24
101	52 50	54 30	54 55	55 08	56 37	79	57 05	7	24
102	0 45	2 10	2 35	2 46	3 43	49	4 05	7	24

TABLE VII.—*Steam-hammer observations—Continued.*

Number of observation.	Driver in position.	Pile in leads.	Hammer on pile.	Start hammer.	Pile driven.	No. of strokes.	Hammer aloft.	Depth of water.	Length of pile.
	m. s.	m. s.	m. s.	m. s.	m. s.		m. s.	Feet.	Feet.
103	4 50	5 55	6 25	6 41	7 13	30	7 35	7	24
104	9 10	10 05	10 30	10 42	11 17	30	11 40	7	24
105	12 25	13 45	14 10	14 35	15 05	27	15 30	7	24
106	16 25	18 10	18 30	18 48	19 23	27	19 45	7	24
107	22 50	23 50	24 15	24 33	25 55	35	26 35	7	24
108	17 00	18 50	19 10	19 19	20 25	33	20 55	7	24

From Table VII Table VIII is obtained, as II was from I.

TABLE VIII.—*Time intervals, &c.*

Number of observation.	Feet driven.	Length of pile.	Depth of water.	Driver in position to pile in leads.	Pile in leads to hammer on pile.	Hammer on pile to start hammer.	Pile in leads to pile driven.	Pile driven to hammer aloft.	To put the driver in position.
	Feet.	Feet.							
73	14	24	7	70	20	8	2 2	35	5 2
74	14	24	7	70	30	55	2 4	35	6 2
75	14	24	7	60	50	28	3 3	30	5 2
76	14	24	7	55	25	15	3 1	30	4 2
77	14	24	7	35	55	26	3 7	20	4 6
78	14	24	7	60	30	5	3 6	25	2 3
79	14	24	7	65	30	30	3 0	25	5 6
80	14	24	7	60	25	15	2 2	40	4 8
81	14	24	7	50	35	12	2 0	25	3 1
82	14	24	7	70	35	7	2 2	25	4 8
83	14	24	7	90	35	12	2 2	25	5 3
84	14	24	7	180	50	25	4 1	85	2 2
85	14	24	7	270	30	10	1 9	25	7 5
86	14	24	7	120	40	18	2 4	25	5 8
87	14	24	7	75	20	15	3 0	25	6 0
88	14	24	7	55	30	5	2 3	35	4 6
89	14	24	7	90	30	13	2 7	25	5 4
90	14	24	7	70	30	2 3	2 3	25	5 0
91	14	24	7	60	25	17	2 8	25	10 0
92	14	24	7	75	40	15	2 9	25	5 2
93	14	24	7	95	25	23	8 1	25	7 3
94	14	24	7	60	15	10	1 9	45	5 5
95	14	24	7	90	35	20	2 7	25	7 6
96	14	24	7	80	15	23	1 2	25	8 7
97	14	24	7	60	20	12	1 0	25	3 1
98	14	24	7	57	23	18	1 2	20	3 4
99	14	24	7	45	35	15	1 4	36	3 6
100	14	24	7	70	30	15	1 6	58	4 4
101	14	24	7	100	25	13	2 1	28	7 9
102	14	24	7	75	25	11	1 6	22	4 1
103	14	24	7	65	30	16	1 8	22	4 2
104	14	24	7	55	25	12	1 2	23	3 3
105	14	24	7	80	25	25	1 3	25	4 0
106	14	24	7	105	20	18	1 2	22	6 4
107	14	24	7	60	25	18	2 1	30	4 2
108	14	24	7	110	20	9	1 6	30	.....
Mean	14	24	7	80.2	29.7	16.0	2.2	27.4	4.9

The following shows our mean times as compared with the Chicago means:

	Chicago.	Saint Louis.
Feet driven	14.0	13.6
Driver in position to pile in leads	1.3	17.7
Pile in leads to pile driven	2.2	8.7
Depth of water, feet	7	15.5
Length of pile, feet	24	34.8
Current (miles per hour)	0	3-6

The immense difference between the amount of work done at the two localities is caused almost entirely by the current. In the river it is a continual struggle both to hold the flat in place and the pile in the leads; at Chicago there is no strain on the lines holding the flat, which is disturbed only by wind and waves, and two men hold the pile in the leads with a single light line, till the hammer is placed on it.

The downward velocity of the pile was no greater at Chicago than here, as numerous measurements proved, but it was continuous; while here stoppages are constantly occurring, from the time the pile starts till it stops.

PART III.—POSSIBLE ECONOMY OF USING STEAM-HAMMER DRIVERS ON THE MISSISSIPPI.

The cost of the Illinois Central Railroad driver of this form was: steam hammer \$1,593.50 (weight 7,500 pounds); license to build and use the same, \$500; hull, \$2,000; boiler and engine, \$2,333.59; total, \$6,427.09. The weight of this size of hammer is too great for cottonwood piles; the second size, weighing one-half as much, would be what is required. Its cost, free of license if obtained direct from the manufactory, is \$875. The only possible saving would be in lessening the time now spent in actual driving, and this, with our present form, is but a small fraction of that needed per pile. The difference in cost of the present hammer (\$80) and the steam hammer (\$375) is \$795, and under the most favorable circumstances it would take a long time to pay for itself.

The more simple the machinery used, the greater is the chance of real efficiency, when the work is carried on, as under this office, at a distance from machine-shops. If any saving is to be made by extensive change of plant, it must be found in some method of driving more than one pile from each position of the flat, thus eliminating partly the slow and vexatious changes of position in severe currents.

PART IV.—VELOCITY OF PENETRATION AS A FUNCTION OF THE PENETRATION OBTAINED.

It added but little labor to record the time at which each pile had penetrated 2 feet, 4 feet, 6 feet, &c. While I was studying other more important elements involved in practical pile-driving, I therefore incidentally made the observations shown in columns eighteen to twenty-five, inclusive, in Table I, page 18, thinking that in connection with further experiments they might throw some light on the important question of the quantity of water needed for the most efficient work with a combined jet and hammer driver.

Table IX shows the total number of seconds required by each pile from the time it was in the leads till it had penetrated the number of feet at the head of each column. In this table no allowance is made for unusual delays, they are all considered as part of the time occupied in driving; in other words, the table gives the true and entire history of the downward movement of each pile.

TABLE IX.—Seconds from "pile in leads," till pile has penetrated.

No. of observation.	2 feet.	4 feet.	6 feet.	8 feet.	10 feet.	12 feet.	14 feet.	16 feet.	No. of observation.	2 feet.	4 feet.	6 feet.	8 feet.	10 feet.	12 feet.	14 feet.	16 feet.
1..	15	60	80	180	240	300	.....	.....	16..	180	210	250	275	290	312	325	350
2..	90	120	155	175	390	465	630	.....	17..	200	220	780	900	910	925	990	995
3..	315	435	480	590	715	775	810	.....	18..	275	283	298	830	845	860	865	420
4..	90	140	155	173	230	390	435	510	19..	80	70	80	150	205	206	210	300
5..	275	370	470	485	505	515	540	.....	20..	13	14	15	30	50	60	75	95
6..	165	273	310	432	600	.....	.....	.....	21..	390	400	435	448	470	495	520	586
7..	60	330	335	340	600	630	720	.....	22..	110	258	290	345	360	420	430	.....
8..	330	400	415	440	470	490	540	.....	23..	150	220	235	260	295	320	470	505
9..	240	255	350	390	450	510	840	.....	24..	355	375	440	455	515	590	630	.....
10..	70	94	107	135	170	225	270	.....	25..	210	217	225	280	540	575	660	.....
11..	290	305	375	400	460	530	575	1,225	26..	200	210	500	615	620	630	690	710
12..	320	330	345	375	405	410	480	550	27..	360	500	505	545	558	640	670	760
13..	180	285	450	465	615	840	.....	.....	28..	130	135	160	220	265	360	.....	.....
14..	370	380	630	635	673	690	715	785	29..	125	135	145	270	275	280	340	400
15..	370	375	450	460	810	925	.....	.....	30..	480	495	540	660	720	.....	.....	.....

TABLE IX.—Seconds from "pile in leads," till pile has penetrated—Continued.

No. of observation.	2 feet.	4 feet.	6 feet.	8 feet.	10 feet.	12 feet.	14 feet.	16 feet.	No. of observation.	2 feet.	4 feet.	6 feet.	8 feet.	10 feet.	12 feet.	14 feet.	16 feet.
31..	45	140	240	360					52..	150	155	160	195	215	235	270	330
32..	395	495	540	605	720	840			53..	150	210	235	285	375	495		
33..	210	235	435	450	460	622	680		54..	120	175	200	260	335	385		
34..	420	590	590	615	705	765	855		55..	60	110	170	240	315			
35..	90	90	90	240	245	290	295		56..	135	185	215	230	270	315		
36..	210	225	240	540	690	900			57..	120	150	255	380	490			
37..	60	140	190	250	250	310	465		58..	60	130	155	180	360	480	635	
38..	60	90	150	240	270	350	390		59..	30	60	120	140	165	200		
39..	55	70	100	125	195	230	300	875	60..	30	40	65	90	165	225	285	
40..	85	95	100	135	155	190	195	210	61..	70	90	150	160	165	175	200	270
41..	85	90	130						62..								
42..	135	140	150	200	230	250	270	280	63..								
43..	85	130	240	260	275	280			64..								
44..	60	115	175	190	210	480			65..								
45..	255	300	310	325	410	460	550		66..								
46..	45	45	50	60	100	135			67..								
47..	15	85	100	190	270	390	590	720	68..								
48..	195	215	270	272	315	335	840	360	69..	145	170	183	225	250	285	300	
49..	100	160	215	370	585	900			70..								
50..	30	32	34	90	120	135	210	240	71..	30	32	70	110	240	405	540	
51..	5	7	10	15	140	150	180	260	72..	120	150	190	185	300	540		

This table is shown graphically on Plate VII, where the co-ordinate axes represent, the vertical the penetration in feet, the horizontal the time in seconds occupied in attaining the corresponding penetrations. Examining the plate, the following peculiarities are seen:

1. The long time taken in penetrating the first 2 feet. This arises from the fact that the pile is still held by the log-chain line, and thus penetrates only as fast as this line is slackened off. Again, the hammer is not yet on the pile, and it is urged downward only by its own weight. The time to descend till it touches bottom is also included.

2. The irregularity of the movement. The pile usually goes down by sudden jumps, as though the jet made a hole not quite large enough to admit the pile at first, but that the washing away of the sides at last let it fall to the bottom of the hole, or as if the bottom were composed of thin hard layers, separated by relatively much thicker ones of soft alluvion. Both are probably active agents, contributing to the same result.

3. The pile often penetrates the last 2 feet in as little time as any other interval of like amount.

This is explained by the fact that the piles are not intended to support a weight, as in a foundation, but only to resist a tendency to be forced over by the current, drift, and ice. This does not necessitate driving till the pile goes hard, but only to force it deep enough into the soil to prevent lateral movement. Fourteen feet is the distance usually required; in soft bottom, 16 feet or more is the depth driven; in hard bottom 12 feet is ample.

The driving is usually stopped after a penetration of 12 feet has been obtained, first, when the head of the pile (cottonwood) becomes so much battered up as to form an elastic cushion, so that the hammer does not strike a fair blow; second, when the pile penetrates so slowly that it is wasting time to try to force it farther; third, when the head of the pile is at the level desired, provided the depth driven in this last case is sufficient in the bottom there existing to secure stability.

4. Many excessive delays. These are shown on the plot by nearly horizontal portions of a pile's course, preceded and followed by portions which are nearly vertical. They generally indicate that work was temporarily suspended to adjust toggle, line, &c.

5. The sudden descent shown in almost every pile from 2 feet to 6 feet or 8 feet. This is caused by the first placing of the hammer on the pile.

It is plain, inasmuch as some piles (in hard bottom) were driven only 10 feet, and others (in soft bottom) 16 feet, that the simple means of the columns of Table IX would express no law.

If all the piles had been driven (as in foundations) till the velocity of penetration was reduced to some very small value, the complete method of combining the obser-

uations to derive the law of velocity of penetration as a function of the penetration attained would be as follows:

1. Find the absolute time each pile occupied in penetrating the successive intervals of 2 feet.

2. Throw out all times that were marked in the field as vitiated by toggle or other delays.

3. Find the fractional part of the whole time occupied by each pile in real penetration, which was used in penetrating the first 2, 4, 6, 8 feet, &c. The resulting fractions will be called "time fractions."

4. Find the fractional part of the entire penetration of each pile which corresponds to 2, 4, 6, 8 feet, &c. The resulting fractions will be called "distance fractions."

5. Take the mean of all the time fractions (above defined) which correspond to equal distance fractions (above described).

For clearer appreciation of the above, consider the case of two piles, one driven "a" feet, the second " a " \times "a" feet.

The time fractions obtained by above head, 3 correspond in both to 2 feet, 4 feet, 6 feet, &c., but $\frac{2 \text{ feet}}{a \text{ feet}}$, $\frac{4 \text{ feet}}{a \text{ feet}}$, $\frac{6 \text{ feet}}{a \text{ feet}}$ are larger fractions than $\frac{2 \text{ feet}}{a \times a \text{ feet}}$, $\frac{4 \text{ feet}}{a \times a \text{ feet}}$, $\frac{6 \text{ feet}}{a \times a \text{ feet}}$, &c., therefore the time fractions do not correspond to equal portions of the entire penetration in the two cases, and should, therefore, not be combined into one mean.

Piles driven 16 feet would thus determine the points on the curve corresponding to one-eighth, two-eighths, three-eighths, &c.; those driven 14 feet, those corresponding to one-seventh, two-sevenths, three-sevenths, &c.; those driven 12 feet, those corresponding to one-sixth, two-sixths, three-sixths, &c.; those driven 10 feet, those corresponding to one-fifth, two-fifths, three-fifths, &c., and so on. These operations are shown in the following tables:

TABLE X.—Absolute time intervals.

No. of observation.	0 to 2 feet.	2 to 4 feet.	4 to 6 feet.	6 to 8 feet.	8 to 10 feet.	10 to 12 feet.	12 to 14 feet.	14 to 16 feet.	No. of observation.	0 to 2 feet.	2 to 4 feet.	4 to 6 feet.	6 to 8 feet.	8 to 10 feet.	10 to 12 feet.	12 to 14 feet.	14 to 16 feet.
1.	15	45	20	100	60	60			37.	60	80	50	60	0	60	155	
2.	90	30	35	20	30	75	165		38.	60	30	60	90	30	80	40	
3.	315	120	45	110	125	60	35		39.	55	15	30	35	60	35	70	75
4.	90	50	15	18	57	160	45	75	40.	85	10	5	35	20	25	15	15
5.	275	95	100	15	20	10	25		41.	85	5	30					
6.	165	108	37	122	168				42.	135	5	10	50	30	20	20	10
7.	60	270	5	5		30	190		43.	85	45	110	20	15	5		
8.	330	70	15	25	80	20	50		44.	60	55	55	20	20	270		
9.	240	15	95	40	60	60			45.	255	45	10	15		50	90	
10.	70	24	13	28	35	55	45		46.	45	0	5	10	40	35		
11.	290	15	70	25	60	70	45		47.	15	70	15	90		120	200	130
12.	320	10	15	30	30	5	70	70	48.	195	20	55	2	43	20	5	20
13.	180	105	165	15		225			49.	100	60	55		215	325		
14.	370	10		5	38	17	25	20	50.	30	2	2	58	30	15	75	30
15.	370	5	75	10		115	13		51.	5	2	3	5		10	30	80
16.	180	30	40	25	15	22	13	25	52.	150	5	5	35	20	20	85	60
17.	200	20		120	10	15	65	5	53.	150	60	25	50	90	120		
18.	275	8	15	32	15	15	5	55	54.	120	55	25	60	75	50		
19.	60	10	10	70	55	1	4	90	55.	60	50	60	70	75			
20.	13	1	1	15	20	10	15	20	56.	135	50	30	15	40	45		
21.	390	10	35	5	30	25	30	61	57.	120	30	105	125	110			
22.	110	148	32	55	15	60	10		58.	60	70	25	25		150	125	
23.	150	70	15	25	35	25	150	125	59.	30	30	60	20	25	35		
24.	355	20	65	15	60	75	40		60.	30	10	25	25	75	60	60	
25.	210	7	8	55		35	175		61.	70	20	60	10	5	10	25	70
26.	200	10		115	5	10	60	20	62.								
27.	360	140	5	40	13	82	30	90	63.								
28.	130	5	25	60	45	95			64.								
29.	125	10	10	125	5	5	60	60	65.								
30.	480	15	45		60				66.								
31.	45	95	100	120					67.								
32.	395	100	45	65	115	120			68.								
33.	210	25		15	10		58		69.	145	25	13	42	25	35	15	
34.	420	170	0	25	90	60	90		70.	90	30	120	10	20	75		
35.	90	0	0	150	5	45	5		71.	30	2	38	40	130	165	135	
36.	210	15	15		120	240			72.	120	30	80	55	15	240		

In- a.	14 min- utes.	16 min- utes.
973	1.0000	1.0000
133	.8000	1.0000
1509	.9284	1.0000
9924	.9641	1.0000
1000	.....	.....
3014	1.0000	.....
3000	.....	.....
4845	.7970	1.0000
9305	.9444	1.0000
0000	.....	.....
5624	.8750	1.0000
1847	.4071	1.0000
7128	.8182	1.0000
0000	.....	.....
0000	.....	.....
7248	1.0000	.....
0900	.....	.....
7984	1.0000	.....
6485	.7408	1.0000

ERRATA.

APPENDIX T OF THE ANNUAL REPORT OF THE CHIEF OF ENGINEERS, 1883.

Page 1274, line 16, " $a \times a$ " should read $a + b$.

Page 1274, line 18, $a \times a$ should read $a + b$ in both cases.

Page 1274, line 19, $a \times a$ should read $a + b$.

Page 1274, line 20, therefore should be omitted.

Page 1275, the heads of the columns should read feet in every case that now reads minutes.

TABLE XI.—Time ft.

No. of obs. vaton.	3 min- utes.	4 min- utes.	6 min- utes.	8 min- utes.	10 min- utes.	12 min- utes.	14 min- utes.	16 min- utes.	No. of obs. vaton.
1	.0500	.2000	.2007	.6001	.8000	1.0000	1.0000	.....	38
2	.3023	.2988	.3486	.3935	.4610	.6297	1.0000	.....	39
3	.3890	.5379	.5929	.7279	.8828	.9566	1.0000	.....	40
4	.1706	.2745	.3049	.3402	.4519	.7652	.8535	1.0000	41
5	.5093	.6851	.8705	.9083	.9354	.9640	1.0000	.....	42
6	.2748	.4547	.5165	.7199	1.0000	.....	.....	.....	43
7	.1072	.5894	.5983	.6072	.6066	.....	.....	.....	44
8	.8109	.7406	.7684	.8146	.8702	.9073	1.0000	.....	45
9	.4766	.5000	.6963	.7637	.8823	1.0000	.....	.....	46
10	.2504	.3453	.3965	.6003	.8234	.8334	1.0000	.....	47
11	.5043	.5304	.6521	.6956	.7990	.9217	1.0000	.....	48
12	.5821	.6000	.6276	.6822	.7308	.7459	.8724	1.0000	49
13	.2909	.4131	.6523	.6739	.....	1.0000	.....	.....	50
14	.7830	.7836	.....	.7839	.8722	.9073	.9588	1.0000	51
15	.6424	.6321	.7825	.7999	.....	1.0000	.....	.....	52
16	.5140	.5097	.7140	.7854	.8292	.8911	.9284	1.0000	53
17	.4597	.5057	.....	.7815	.8446	.8591	.9487	1.0000	54
18	.6546	.6727	.7094	.7956	.8213	.8570	.9090	1.0000	55
19	.2900	.2230	.2966	.4999	.6431	.6867	.7001	1.0000	56
20	.1368	.1473	.1578	.3158	.5290	.6314	.7894	1.0000	57
21	.4053	.6867	.7444	.7549	.8051	.8488	.9070	1.0000	58
22	.2539	.6002	.6747	.8026	.8274	.9799	1.0000	.....	59
23	.2353	.3701	.3853	.4373	.4492	.5381	.7903	1.0000	60
24	.6636	.6854	.6867	.7223	.8187	.9367	1.0000	.....	61
25	.4285	.4428	.4591	.6714	.....	.6439	1.0000	.....	62
26	.4702	.5000	.....	.7738	.7857	.8095	.8524	1.0000	63
27	.4732	.6573	.6639	.7165	.7337	.8418	.8615	1.0000	64
28	.3614	.3753	.4448	.6115	.7365	1.0000	.....	.....	65
29	.3126	.3376	.3626	.6752	.6878	.7006	.8500	1.0000	66
30	.7998	.8248	.8999	.....	.....	.....	.....	.....	67
31	.1250	.3846	.6066	1.0000	.....	.....	.....	.....	68
32	.4699	.5890	.6426	.7201	.8570	1.0000	.....	.....	69
33	.6604	.7391	.....	.7953	.8177	.....	1.0000	.....	70
34	.4911	.6899	.6899	.7191	.8244	.8947	1.0000	.....	71
35	.3052	.3052	.3052	.8188	.8307	.9832	1.0000	.....	72
36	.3499	.3749	.39095999	1.0000	73
37	.1290	.3010	.4085	.5375	.5375	.6680	1.0000	Mean

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TABLE XII.—*Distance fractions.*

Depth driven.	2 feet.	4 feet.	6 feet.	8 feet.	10 feet.	12 feet.	14 feet.	16 feet.
16 feet.....	.125	.250	.375	.500	.625	.750	.875	1.000
14 feet.....	.143	.286	.429	.572	.715	.857	1.000	.....
12 feet.....	.167	.333	.500	.667	.833	1.000	.....	.....
10 feet.....	.200	.400	.600	.800	1.000	.....	.....	.....
8 feet.....	.250	.500	.750	1.000	.....	.....	.....	.....
6 feet.....	.333	.667	1.000	.....	.....	.....	.....	.....
4 feet.....	.500	1.000	.....	.....	.....	.....	.....	.....
2 feet.....	1.000	.....	.....	.....	.....	.....	.....	.....
0 feet.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE XIII.—Corresponding time and distance fractions—Continued.

No. of ob- servations.	Distance fractions														
	.125	.143	.167	.200	.250	.298	.333	.375	.400	.429	.500	.572	.600	.632	.667
42	.4908				.4987			.5345			.7133			.8207	
43		.3034				.4641	.4641				.8667	.8293			.9641
44		.1250				.2396	.2396				.8542	.8939			
45		.5483				.6451	.6451			.6666	.6666	.6980			.8014
46		.3344					.3344	.1564			.3688				
47	.0234				.1330			.2970			.7557				.7970
48	.5417				.5973			.7501							.9444
49		.1224				.2119									
50					.1333			.1416			.3749				.8750
51	.0382				.0510			.0732			.1104				.4071
52	.4550				.4702			.4854			.5914				.8182
53		.3053				.4244	.4244				.4747				
54		.3119				.4548	.4548				.5196				.7575
55			.1905					.55	.3494				.5399		.8702
56			.4285				.5874			.6827					
57		.1319		.2449				.3061				.3953	.5204		.7757
58			.1500			.2857	.3000		.3405		.5909				.8249
59		.1082				.1403				.2380		.5157			
60					.3335		.5558				.5929			.6114	.7894
61	.2594														
62															
63															
64															
65															
66															
67															
68		.4531				.5682			.6095			.7495			
69			.2608			.3477				.6935					.9498
70		.0556				.0586			.1297			.2038			.7500
71										.4252					
72			.2218			.2773									
Mean	.3700	.3447	.3046	.3750	.4065	.4651	.4141	.4415	.4387	.5180	.5577	.6285	.6442	.6975	.8458

Table XIII is shown graphically on Plate VIII, Fig. 2. The irregularity of the mean curve there plotted shows either that there is no law which is sufficiently marked to be shown by such a limited number of observations, or that the assumptions made for purposes of discussion were not in accordance with the real facts. That the latter is the case is, I think, indicated by the smooth curve obtained under the following assumptions, though much of the regularity may be due to the fact that each point is determined by the mean of nearly seventy-two observations.

That the piles were not driven in equally resisting bottom is well known, but the reason that many of them were not driven the full depth of 16 feet was that the master driver had struck too heavy blows for the head of the cottonwood pile to stand, and the head had thus been utterly destroyed before the pile was fully driven. On this account it would seem that a better way to discuss the observations would be to assume that the ratio of the velocity of penetration at the 2-foot depth to that at 4 feet is constant, although the absolute values of these velocities are different for all varieties of bottom; and to extend this law to 6 feet, 8 feet, 10 feet, &c.

In other words, assume that a represents the velocity when a penetration of 2 feet is attained, ba that at 4 feet, ca that at 6 feet, &c., for any given locality; then at any other locality where the velocity at 2 feet is a feet, that at 4 feet will be ba feet, that at 6 feet ca feet, &c., in which b, c , &c., have the same values as before. Making these assumptions, the object is to obtain the values of b, c , &c., from the observations.

Under this hypothesis the difference in the hardness of the bottom at different places makes it necessary, as before, to construct a table of "time fractions;" but as the ratio of velocity at 2 feet to that at 4 feet, 6 feet, 8 feet, &c., is what is desired, the time fractions must be combined according to the absolute penetration in feet to which they correspond instead of combining as before according to corresponding "distance fractions."

Table XI is then already in the proper shape for plotting. Plate VI, Fig. 1, this table, plotted, shows very clearly some peculiar features of the history of the mean pile. The slow descent for the first 2 feet is shown as before, then the rapid descent from 2 feet to 6 feet, which is caused by first placing the hammer on the pile. From 6 feet to 10 feet the penetration is less rapid, as the hammer is still at rest, and acts only as dead weight. From 10 feet on the penetration is again more rapid, as by this time the hammer is fairly in action.

The numbers actually shown by this mean curve are almost exactly those pointed out by the means of a number of observations I took to determine the time at which the above changes in the manipulation of the pile takes place.

The changes in the values of b, c , &c., are so slight that it is practically correct to state that for the depths the piles are driven here there is no appreciable difference in their rate of penetration from the start till they are at their final place of rest. Plate V shows that with many piles the resistance does increase to a marked extent, but taking the long average the last 2 feet are driven in just about the time needed for any other 2 feet.

Table XIV, showing the fractional part of the entire time occupied in penetrating each individual 2-foot interval, is added as of possible interest; it shows the irregularities for single piles more plainly than Table XI.

TABLE XIV.—Time fractions for individual 2-foot intervals.

No. of obser- vations.	First 2 feet.	Second 2 feet.	Third 2 feet.	Fourth 2 feet.	Fifth 2 feet.	Sixth 2 feet.	Seventh 2 feet.	Eighth 2 feet.	No. of obser- vations.	First 2 feet.	Second 2 feet.	Third 2 feet.	Fourth 2 feet.	Fifth 2 feet.	Sixth 2 feet.	Seventh 2 feet.	Eighth 2 feet.
1	0500	1500	0687	3334	1999	2000	3703	0450	87	1290	1420	1075	1290	0000	1201	3334	.....
2	2023	0675	0787	0787	0675	1887	3703	0450	88	1338	0780	1538	2307	0789	2053	1027	.....
3	3390	1483	0556	1338	1544	0743	0434	0434	89	1468	0400	0909	0933	1000	0684	1987	.....
4	1766	0670	0594	0353	1117	3183	0983	1465	40	4046	0476	0238	1687	0961	1191	0716	.....
5	5093	1753	1854	0978	0371	0588	0060	.....	41	7080	0178	2502	1687	0961	1191	0716	.....
6	2748	1799	0818	2634	2801	0584	3304	0324	42	4308	0179	0368	1738	1074	0717	0639	.....
7	1072	0822	0989	0689	0584	0571	0927	.....	43	3034	1607	0398	0716	0687	0180	.....	.....
8	6109	1287	0278	0462	0556	0571	0927	.....	44	1230	1140	1149	0523	0617	0623	1006	.....
9	4706	0294	1363	0784	1176	1177	.....	.....	45	5453	0908	0315	0523	0617	0623	1006	.....
10	2594	0989	0482	1038	1286	3038	1686	.....	46	8344	0000	0844	0741	2906	2386	3125	.....
11	5043	0261	1217	0435	1043	1218	0783	.....	47	0234	1096	0284	1406	1193	0556	0189	.....
12	5821	0182	0273	0646	0646	0091	1276	.....	48	5417	0556	1628	0056	1193	0556	0189	.....
13	2609	1322	2692	0316	.....	3261	1276	.....	49	1324	0786	0729	.....	2947	4305	.....	.....
14	7830	0209	.....	0103	0783	0351	0615	.....	50	1250	0038	0033	2333	1250	0923	8126	.....
15	6434	0097	1304	0174	.....	2001	0615	.....	51	0862	0148	0223	0872	1250	0923	8126	.....
16	5140	0857	1143	0714	0428	0629	0873	.....	52	4560	0152	0152	1060	0905	0904	1059	.....
17	4597	0490	.....	2758	0231	0845	1498	.....	53	8033	1211	0508	1006	1832	2426	2224	.....
18	6546	0191	0357	0762	0357	0857	0120	.....	54	3119	1429	0943	1558	1848	1298	.....	.....
19	2000	0333	0333	2333	1832	0036	0124	.....	55	1905	1589	1905	2231	2380	.....	.....	.....
20	1368	0106	0105	1578	2104	1054	2106	.....	56	4285	1589	0953	0476	1270	1427	.....	.....
21	6653	0214	0597	0985	0502	0417	0502	.....	57	2449	0612	2143	2553	2243	.....	.....	.....
22	2559	3443	0745	0348	0848	1895	0921	.....	58	1319	1538	0548	0648	1250	1751	2752	.....
23	2523	1178	0252	1279	0348	0419	2532	.....	59	1500	1500	2999	1000	1250	1751	2752	.....
24	5336	0318	1033	0238	0652	1190	0635	.....	60	1052	.....	0331	0877	2631	2106	2106	.....
25	4285	0143	0163	1123	0652	1190	0635	.....	61	2694	0741	2223	0877	0185	0871	0923	.....
26	4762	0238	.....	2738	0119	0238	0476	.....	62	.....	.....	.....	.....	.....	.....	.....	.....
27	4732	1841	0066	0526	0172	1081	0397	.....	63	.....	.....	.....	.....	.....	.....	.....	.....
28	3614	0139	0695	1667	1250	2635	0397	.....	64	.....	.....	.....	.....	.....	.....	.....	.....
29	3126	0250	0250	3126	0124	1500	1500	.....	65	.....	.....	.....	.....	.....	.....	.....	.....
30	7988	0250	0751	.....	1001	.....	.....	.....	66	.....	.....	.....	.....	.....	.....	.....	.....
31	1250	2636	2780	8334	.....	.....	.....	.....	67	.....	.....	.....	.....	.....	.....	.....	.....
32	4699	1191	0636	0775	1369	1430	.....	.....	68	.....	.....	.....	.....	.....	.....	.....	.....
33	6904	0787	.....	0472	0775	.....	.....	.....	69	4831	0931	0433	1490	0684	1169	0502	.....
34	4011	1988	.....	0292	1053	0703	1823	.....	70	2606	0969	8478	0291	0379	2175	2175	.....
35	3952	0000	0000	5086	0168	1528	0168	.....	71	0554	0937	0704	0741	2447	3045	2600	.....
36	3499	0250	0250	.....	2000	4901	.....	.....	72	2218	0556	1479	1021	0289	4488	.....	.....

PART V.—PROJECT FOR A MULTIPLE-LEADS DRIVER.

Table V, page 28, shows that in driving 20,000 piles \$14,255.94 were spent in placing the pile-drivers in position, and by this is meant the change from the position of one pile to the next, and no account is taken of the long moves from one line to another. All this time is absolutely lost as far as any advantage is concerned, and some means by which it can be shortened or avoided is most desirable.

The most practicable and at the same time least expensive method seems to be some arrangement by which putting the flat once in position shall enable the engine to drive several piles.

The object to be obtained is to devise a driver which shall drive the greatest possible number of piles at each position, and still be at least as easy to put in place as the present form.

With the idea of testing the practicability of handling a large flat in severe currents, I tried the experiment of lashing three pile-drivers together, and driving all one day in a current of $5\frac{1}{2}$ miles an hour in a depth of water of 19 feet. The area of the flat thus joined was 60 feet by 60 feet, and would have accommodated eleven leads, properly spaced, for work on the hurdle lines.

The piles driven by this combination are seventeen to thirty-one, inclusive.

The times required to move the flat was as follows: 9.4 minutes, 11.4 minutes 8.4 minutes, 34.0 minutes. The first three were simple shifts on the same line; the fourth was a general move from the down-stream (brace) line to the up-stream (drift) line, a distance of about 60 feet across the current and 40 feet up-stream. In the position on the up-stream line three anchors were used (average weight 200 pounds), and when the strain was brought evenly on them they held perfectly.

Two were unable to hold the flat alone. Great trouble was found in raising the anchors after the experiment was over, they had penetrated so deeply under the heavy strain.

The drivers did about two-thirds as much work as usual when thus combined, and this, although all three had to wait till the slowest one had driven its pile.

The result of the experiment seemed to indicate that there was no special difficulty in holding and moving such a flat.

The cost of building such a large hull, stiff enough to support the great weight which would be concentrated on one end, and of constructing such complicated machinery as eleven leads run by a single engine would demand, is so great that before recommending it a further test is deemed needful. With this idea I have designed a three-lead driver to be floated on one of the present hulls.

The machinery remains unchanged, and the only expense is the construction of two new leads, and a general change of position of the machinery, in order to trim the flat.

Plate—" is drawn to a scale of half inch = one foot, and will be found to be sufficiently accurate to be used as a working drawing.

The flat will be available for a common driver if the results do not fulfill all that is anticipated; the extra leads will be available at any time in the repair of other drivers, and the expense of moving the machinery back to its present place is all that is needed to reconvert the multiple into a common driver.

All necessary details can be readily obtained from measurements on the drawing.

Very respectfully, your obedient servant,

FREDERIC V. ABBOT,
First Lieutenant of Engineers.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

* Plate not forwarded.

1282 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

16.

Record of gauge at Grafton, Ill., for the fiscal year ending June 30, 1883.

[Height of water above plane 200 feet below the Saint Louis City directrix.]

Day.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>
1	212.23	201.88	197.50	195.74	196.70	199.12	197.45	199.50	211.45	202.85	205.15	207.00
2	12.95	01.85	97.72	95.68	98.70	99.00	97.12	199.25	11.15	02.50	05.45	07.50
3	13.80	01.80	97.54	95.60	98.65	98.85	97.00	199.00	10.60	02.08	05.75	07.20
4	14.30	01.70	97.55	95.55	98.50	98.00	96.70	199.10	10.20	01.52	04.05	04.85
5	14.50	01.48	97.52	95.48	98.45	97.75	96.40	199.22	09.90	01.00	04.26	04.90
6	14.50	01.52	97.68	95.46	98.30	97.80	96.25	199.55	09.35	01.15	04.50	04.10
7	14.80	01.70	97.75	95.45	98.00	97.00	96.00	199.50	09.40	01.43	04.75	04.00
8	13.98	01.75	97.90	95.40	97.92	96.50	96.00	199.35	09.30	02.50	04.93	04.18
9	13.50	01.60	98.10	95.40	97.80	96.15	95.85	199.22	08.95	03.12	07.10	04.00
10	12.85	01.32	98.24	95.40	97.64	95.00	95.70	199.10	08.58	03.12	07.20	07.12
11	12.15	01.00	98.20	95.50	97.52	94.92	95.50	199.05	07.90	02.98	07.20	07.70
12	11.59	00.65	98.25	95.54	97.45	94.00	94.80	199.00	07.40	02.72	07.18	08.04
13	10.75	00.26	98.00	95.55	97.50	98.85	99.05	199.05	06.90	02.61	07.10	08.40
14	10.00	199.92	97.90	95.75	97.75	98.65	200.25	199.52	06.35	02.40	07.25	08.85
15	09.30	99.70	97.78	96.00	97.65	98.65	00.25	202.00	06.12	02.45	07.42	09.35
16	08.70	99.62	97.65	96.15	97.50	98.85	00.58	05.10	05.95	02.50	07.65	19.15
17	08.14	99.55	97.58	96.20	97.60	94.00	01.40	07.70	05.40	02.50	07.82	11.85
18	07.70	99.30	97.35	96.75	97.60	94.00	01.50	08.85	05.35	02.63	08.00	12.00
19	07.25	99.05	97.10	97.80	97.95	94.20	00.55	10.25	05.28	02.75	08.70	13.75
20	06.80	98.80	97.00	97.50	96.05	94.50	199.09	11.00	05.20	02.93	09.10	13.85
21	06.35	98.62	96.92	97.65	96.20	94.60	99.42	11.30	05.15	03.00	09.30	14.27
22	05.00	98.45	96.70	97.75	96.20	94.95	99.00	11.85	05.10	03.30	10.00	14.50
23	04.65	98.35	96.50	97.80	96.40	95.75	98.50	09.72	05.02	03.52	10.00	14.62
24	04.44	98.20	96.40	97.80	96.42	96.25	98.10	12.05	04.94	03.91	10.00	14.65
25	04.20	98.20	96.32	97.92	96.58	96.75	97.00	12.05	04.70	04.05	09.75	14.70
26	03.80	98.20	96.25	97.92	96.75	97.10	98.65	11.98	04.15	04.15	09.40	14.25
27	03.32	98.14	96.08	98.00	96.75	97.35	200.00	11.65	03.70	04.30	09.20	13.80
28	02.90	97.90	95.95	98.22	96.80	97.35	199.70	11.50	03.80	04.43	08.72	13.05
29	02.62	97.72	95.92	98.40	96.92	97.40	99.80	.....	03.00	04.55	08.54	12.45
30	02.45	97.55	95.85	98.50	99.00	97.62	200.00	.....	02.65	04.86	08.80	11.40
31	02.12	97.80	.....	98.65	.....	97.55	00.15	.....	02.14	.....	08.02	.....

Navigation suspended on account of ice, December 7 to December 23, and from January 1 to February 25.

Record of gauge at Gray's Point, Missouri, for the fiscal year ending June 30, 1883.

[Height of water above a plane 200 feet below the Saint Louis City directrix.]

Day.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>
1	115.21	104.91	98.01	95.11	97.81	98.21	98.51	95.11	117.51	108.01	107.51	113.41
2	15.91	04.61	97.91	95.01	98.11	98.11	98.16	94.21	17.11	08.21	07.41	12.68
3	16.61	04.06	97.81	94.86	98.31	97.91	98.01	84.31	16.41	05.91	07.41	12.11
4	17.46	03.91	97.81	94.76	98.41	97.61	95.61	97.21	15.66	05.01	07.51	11.66
5	18.21	04.16	97.91	94.71	98.31	97.51	95.31	96.81	14.66	05.01	07.41	11.21
6	18.51	04.66	97.71	94.61	98.16	97.31	95.11	96.51	13.66	05.44	07.41	10.61
7	18.61	05.11	97.71	94.51	98.01	97.11	94.61	96.51	12.66	05.61	07.81	10.21
8	18.61	05.11	97.56	94.41	97.91	96.66	94.16	96.41	12.21	05.41	07.21	10.61
9	18.41	04.66	97.56	94.41	97.81	95.76	98.76	96.41	11.91	06.11	07.11	11.66
10	18.11	04.11	97.56	94.41	98.01	95.21	93.66	96.61	11.51	06.76	07.11	13.01
11	17.51	03.66	97.71	94.31	97.66	94.41	93.41	97.01	11.16	07.41	07.11	13.21
12	16.46	03.31	97.81	94.41	97.91	93.46	92.66	97.81	10.31	07.61	07.01	13.51
13	15.51	02.76	97.81	94.51	98.41	92.66	92.51	98.51	09.41	07.61	07.01	14.61
14	14.41	02.51	97.81	94.66	98.11	92.16	92.11	100.21	08.66	07.41	07.01	14.66
15	13.36	02.06	97.61	94.76	98.41	92.01	91.66	103.91	08.01	07.31	07.01	15.41
16	12.51	01.66	97.36	95.01	97.91	91.76	91.66	106.51	07.31	06.91	07.21	16.51
17	11.76	01.51	97.21	95.81	98.01	91.11	92.01	111.91	07.11	06.91	07.91	17.41
18	11.31	01.16	97.01	95.41	97.66	90.66	92.81	115.21	06.66	06.81	08.91	18.11
19	11.06	00.91	96.91	95.51	97.16	90.51	92.66	117.66	06.41	06.81	10.21	18.66
20	10.91	00.51	97.11	95.76	97.01	90.66	92.66	118.31	06.11	06.11	11.81	19.41
21	10.66	00.11	96.86	96.41	96.91	91.41	91.76	117.66	05.91	05.66	13.11	19.91
22	10.61	99.76	96.51	97.01	96.91	92.41	91.81	117.01	06.01	07.41	13.51	20.31
23	10.31	99.61	96.41	97.16	96.91	92.76	90.76	117.01	06.11	08.66	13.91	20.51
24	09.66	99.31	96.21	97.16	97.01	93.66	90.76	117.31	06.01	09.51	14.01	21.01
25	09.76	99.11	96.01	97.16	96.81	94.66	91.01	117.66	06.01	09.66	13.41	21.21
26	09.61	98.91	95.76	97.16	96.91	95.61	91.31	118.11	06.01	08.31	13.41	21.51
27	07.31	98.91	95.51	97.16	96.81	94.31	92.11	118.11	05.76	08.01	12.81	21.66
28	04.51	98.66	95.21	97.31	96.81	94.66	93.01	117.66	05.66	08.41	12.51	21.66
29	03.66	98.61	95.51	97.31	97.01	94.66	95.16	.....	05.61	08.01	12.51	21.51
30	05.31	98.51	95.21	97.41	97.11	94.66	95.76	.....	05.41	07.66	13.51	21.11
31	05.11	98.41	.....	97.51	.....	96.61	94.91	.....	05.41	.....	14.01	.....

Isigation suspended on account of ice, January 2 to February 6, and from February 16 to February 21.

18.—Depth of water upon the bars between Saint Louis and Cairo as reported by pilots.

[In feet.]

Date.	Stages above standard low water by Saint Louis gauge.	Name of steamer furnishing report.	Arenal Island.																						
1882.																									
Aug.																									
1	13.30	Humphreys	22	21	18	10	12	16	9	12	10	16	12	10	16	12	10	16	12	10	16	12	10	16	12
2	12.90	do	21	20	18	9	10	18	9	12	10	16	12	10	16	12	10	16	12	10	16	12	10	16	12
3	12.90	John B. Maude																							
4	12.90	Henry Lowrey																							
5	13.83	City of Cairo	21	16	16	9	12	16	9	12	10	16	12	10	16	12	10	16	12	10	16	12	10	16	12
6	13.83	City of Helena																							
7	13.83	City of Vicksburg	15	16	9	12	16	9	12	10	16	12	10	16	12	10	16	12	10	16	12	10	16	12	10
8	13.83	Humphreys	22	21	18	10	12	16	9	12	10	16	12	10	16	12	10	16	12	10	16	12	10	16	12
9	12.90	Ste. Genevieve																							
10	12.90	do																							
11	12.90	Humphreys	22	21	18	10	12	16	9	12	10	16	12	10	16	12	10	16	12	10	16	12	10	16	12
12	12.45	City of Baton Rouge																							
13	11.50	Humphreys	21	20	18	9	10	18	9	12	10	16	12	10	16	12	10	16	12	10	16	12	10	16	12
14	11.50	City of Greenville																							
15	11.50	City of Helena	10	8	9	12	16	9	12	10	16	12	10	16	12	10	16	12	10	16	12	10	16	12	10
16	11.50	City of Helena																							
17	9.85	City of Helena	20	18	16	9	12	16	9	12	10	16	12	10	16	12	10	16	12	10	16	12	10	16	12
18	9.85	do	19	18	16	9	12	16	9	12	10	16	12	10	16	12	10	16	12	10	16	12	10	16	12
19	9.20	City of Vicksburg	12	6	8	9	12	16	9	12	10	16	12	10	16	12	10	16	12	10	16	12	10	16	12
20	8.70	Humphreys	19	17	12	8	9	12	16	9	12	10	16	12	10	16	12	10	16	12	10	16	12	10	16
21	8.45	A. P. Silver																							
22	8.15	Ste. Genevieve	2	9	8	7	12	16	9	12	10	16	12	10	16	12	10	16	12	10	16	12	10	16	12
23		City of Providence																							

[illegible]

Sept.

[illegible]

T 2.

IMPROVEMENT OF THE HARBOR AND MISSISSIPPI RIVER AT ALTON,
ILLINOIS.

Operations at this locality were carried on under an allotment made by Congress from the general appropriation for improving the Mississippi between the Illinois and Ohio rivers. Their history is given in the report upon that work. The favorable season of last autumn enabled the work to be done at a less cost than that previously estimated. The dike advanced so far towards completion and its action upon the shoal in front of Alton landing has been so favorable that it is quite probable that the desired result will be attained without fully completing the dike as originally designed. Considerable settling, however, is to be expected, and in order to preserve the present efficiency of the dike a sum of money sufficient to keep it in repair should be available. An appropriation of \$5,000 is accordingly recommended.

Money statement.

Amount (estimated) required for completion of existing project.....	\$5,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	5,000 00

T 3.

IMPROVEMENT OF MISSISSIPPI RIVER OPPOSITE THE CITY OF SAINT
LOUIS, MISSOURI.

The river and harbor act of August 2, 1882, contained the following proviso, viz:

That the unexpended sums heretofore appropriated for an ice harbor at Saint Louis, Mo., be, and the same are hereby, transferred and appropriated, to be expended under the direction of the Secretary of War, for the improvement of the channel of the Mississippi River opposite the city of Saint Louis, Mo., by repairing and raising the present low dam across the channel east of Arsenal Island, known as Cahokia Chute, and by the construction of such other works in or near said Cahokia Chute as may be deemed advisable to accomplish the same purpose.

The sums above described amounted to \$60,000.

The locality is shown upon Plate I. The submergible dam across Cahokia Chute, constructed in 1878 and 1879, was originally built to a height of about 5 feet above standard low water, but it had afterwards settled about 3 feet, leaving its crest about 2 feet above standard low water. It had accomplished the object that was expected of it, viz: Directing the channel to the other chute and removing the shoals at the head and at the foot of Arsenal Island. It had caused heavy deposits in Cahokia Chute, large areas of which had reached a height much greater than the dam, and were dry at medium stages. At the higher stages, however, a considerable body of water still passed through this chute, and modified the direction of the channel below, causing certain complications at Horsetail which it was desirable to remove. At such times also there was apt to be a slight erosion of the upper portions of the Illinois bank below the dam. To provide for the future business interests of the locality it will eventually be necessary to entirely re-

claim Cahokia Chute in order to afford free access to the navigable water west of Arsenal Island, increasing at the same time the amount of land available for occupation. One object, then, of the works to be constructed was to fill up Cahokia Chute with deposits of silt.

An important feature of the improvement of this locality is the protection of the west side of Arsenal Island. This work had been begun under the general appropriation for the improvement of the Mississippi River, between the Illinois and Ohio rivers, and was in August last well advanced towards completion. There remained, however, to deposit riprap upon the bank above low water for a length of about 3,375 feet. It was decided to complete this work under the appropriation now under consideration.

One means of hastening the process of filling up the chute was to raise the dam by methods similar to those employed in its original construction, viz, by building it up with layers of brush and stone. Both on account of the wording of the law and on account of the slow action of hurdles located on the east side of the Mississippi so near the Missouri, this method would have been adopted had it been found practicable. An examination made in September showed, however, that portions of the dam were buried in sand to a depth in some cases of 12 feet. It showed also that it would not be possible to enter the chute with vessels during the low-water season which was to follow, and that all operations must be postponed until spring. The latter season being most favorable to the prompt action of hurdles, it was decided to attain the desired result by means of them.

Two hurdles were laid out, one just above the dam and parallel to it and one about midway between the dam and the up-stream end of the chute (see Plate I). Their construction was begun in March, and by the end of the year they were nearly completed. They have caused heavy shoaling, the thickness of the deposit averaging 7 feet over the entire area of the chute above the dam, with a maximum fill in some places of over 18 feet. The amount of solid matter secured is estimated at about 3,000,000 cubic yards.

The work was under the immediate direction of Mr. C. D. Lamb, resident engineer, whose report is appended, marked 19, and under the general supervision of Mr. D. M. Currie, superintending engineer. For details see Appendixes 1 and 19.

The cash expenditures were \$33,903.94. The expenditures including use of equipment were \$47,067.95, of which \$40,873.88 was employed upon the hurdles and \$6,194.07 upon the bank protection.

It is thought that the funds now available will be sufficient to accomplish what may be required during the coming year.

No additional appropriation is recommended at this time.

Money statement.

July 1, 1882, amount available	\$60,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$32,900 54
July 1, 1883, outstanding liabilities	1,093 40
	<hr/> 33,903 94
July 1, 1883, amount available.....	26,096 06
Amount (estimated) required for completion of existing project.....	<hr/> 26,096 06

SAINT LOUIS, MO., July 6, 1883.

MAJOR: I have the honor to submit the following report of operations at Cahokia Chute for the fiscal year ending June 30, 1883.

The object of this work is to improve the Mississippi River opposite the city of Saint Louis by shutting off the water at medium stages from the channel east of Arsenal Island, known as Cahokia Chute. Previous to 1878 this chute was regarded as the main channel of the river, the passage on the west side of the island being impeded by a bar of nearly uniform height extending from the island to the Missouri shore. This bar was scoured out soon after the building of the low-water dam across Cahokia Chute in 1878 and 1879, which, raised to a height of 5 feet above standard low water, caused a deposit across the head of the chute, practically closing it during low water. In order to effect the same result at higher stages, the construction of hurdles was begun in accordance with your instructions dated March 10, 1883. An examination having been made, it was found that the east bank of the island had been washed away above the dam to a maximum width of 300 feet, while the towhead opposite had been advanced about 600 feet since 1879, and that the crest of the dam had sunk to a height of 2 feet above low water near the island and to about 7 feet lower near the Illinois shore, where the bottom was found to consist of very soft mud overlaid with a deposit of sand varying in thickness from 3 feet to 20 feet. A bar opposite the head of the island divided the chute into two channels; the larger one passed down near the towhead on the Illinois shore, the other flowed down next the island until after passing the dam, when it joined the main channel near the Illinois shore.

Hurdle line No. 1 was located 80 feet above and parallel to the dam, and its construction began March 17. Work upon it was pushed forward as rapidly as possible, and the line was completed on the 7th of April, but during the sudden rise of April 23 a section of the line 50 feet long, just above the breach made in the dam during its construction, 400 feet from the Illinois shore, was carried away, the bottom at this point being too soft to withstand any considerable pressure, although the piles were driven to a depth of over 20 feet. Contrary to expectation, this breach did not increase in size and was soon repaired, with the exception of the wattling, which was left till the line above should be completed. Repairs were also made upon the island end of the line which was damaged about the same time. These repairs were completed May 11. Meanwhile the construction of line No. 2, begun April 2, had been nearly completed, when work upon it was interrupted May 17 by the high stage of river which completely submerged the piles. At this time 1,300 feet of the line had been completed, and the remaining 1,200 feet was finished with the exception of the wattling.

The river subsided early in June, and work was resumed on the 5th, but another rise again caused its suspension on the 8th; the only work done during the remainder of the fiscal year being the loading on barges of piles delivered at the works in rafts.

The accompanying tracing shows the condition of the work at the end of the fiscal year. The soundings in black were taken July 2. They indicate a large fill during the season, especially at the head of the chute, where the deposit is in places over 18 feet. The average fill over the entire area between the head of the chute and hurdle line No. 1 is about 7 feet, which would indicate a total deposit of 3,000,000 cubic yards.

The method of construction is materially the same as that used on primary hurdles at other places.

The piles in the hurdle row of line No. 1 were driven 6 feet apart, and protected from drift by a line of piles 20 feet above, driven 12 feet apart. Every alternate pile in the hurdle row was stiffened by a brace-drift bolted to its top and extending to the bottom of the river 24 feet below, where it was fastened to another pile by a clevis. To place this brace in position the clevis is first fastened to the heel of the stick and then slipped over the top of the pile and dropped into position by a pile-driver or derrick. The drift-row and the hurdle-row were stiffened by longitudinal stringers fastened to their tops by screw-bolts, and the whole line was further strengthened by cross-stringers at right angles to the line, and bolted to a pile or stringer in each of the three rows. The bottom between the brace and hurdle rows was protected from scour by a foot-mat 37 feet wide, extending from the brace-piles to a distance of 12 feet above the hurdle row. This mat was built of two layers of brush, crossing each other at right angles, thick enough to hold the stone used in sinking, and was supported during construction by grillage-poles lashed to the piles. The wattling was carried to a stage of 20 feet above low water. Soon after it was begun it was found that the depths were increasing between the drift and hurdle rows. Consequently a section of foot-mat was built and sunk to protect the space between these rows.

The method of construction of line No. 2 was the same as that of No. 1, except that the foot-mat was built and sunk in sections 40 feet wide, and the drift-row was braced

at each intersection of the longitudinal stringers, the braces being attached to the piles on the hurdle-row, and the use of the top stringers was regarded as unnecessary.

The following table shows the amount of work done on each line during the fiscal year:

Line.	Piles.	Braces.	Stringers.	Foundation mattress constructed.	Wattling constructed.
Hurdle line, No. 1	676	172	193	112, 200	23, 400
Hurdle line, No. 2	753	209	85	100, 000	14, 500
Total	1, 429	381	278	212, 200	37, 900

No injury to either line of hurdles can be detected at this stage of river. The well-defined break seen over their whole length shows them to be unbroken, while the fill at the head of the chute has been so great that the pressure upon them is very much less than during the rise of the latter part of May.

Very respectfully, your obedient servant,

C. D. LAMB,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

T 4.

IMPROVEMENT OF THE MISSISSIPPI RIVER AT OR NEAR CAPE GIRARDEAU, MISSOURI, AND MINTON POINT, ILLINOIS.

A full description of the plan of these works was given in my last annual report. At the date of that report the object of the works had been attained, the shoal in front of the Cape Girardeau Landing having been removed. A hurdle to perpetuate these results was in process of construction opposite the town, and a further appropriation was desired to protect portions of the old bank and of the new deposits.

During the autumn season the hurdle opposite Cape Girardeau was completed to a total length of 3,100 feet, after which all operations were suspended and the public property removed to Saint Louis. This hurdle has since suffered some damage from ice. To repair it and to protect the banks in the vicinity, both old and new, the appropriation asked for last year is again recommended.

The good results previously obtained have been maintained throughout the year, the main steamboat channel flowing without obstruction from one end of the landing to the other.

The work was under the immediate direction of Mr. J. A. Worthen, whose report is hereto appended, marked 20:

Money statement.

Amount (estimated) required for completion of existing project..... \$41,820 04
Amount that can be profitably expended in fiscal year ending June 30, 1885. 41,820 04

20.

REPORT OF MR. J. A. WORTHEN, ASSISTANT ENGINEER.

SAINT LOUIS, MO., *January 9, 1883.*

MAJOR: I have the honor to submit the following report of operations for improving the Mississippi River near Cape Girardeau, Missouri, and Minton Point, Illinois, during the half year ending December 31, 1882:

CAPE GIRARDEAU.

Work upon the primary hurdle, which had been suspended May 30 on account of high water, was resumed August 1, and extended over a period of eighty-one days.

During the high-water season no changes of importance had taken place in the position of channels or the general behavior of the river.

When the waters had subsided and active operations were resumed it was found that 120 feet of the outer end of the hurdle had been destroyed and a breach 50 feet in length had been made about 300 feet from the shore. Also other slight injuries to the hurdle had resulted from the heavy masses of floating drift-wood. The damage was at once repaired and the work of construction carried toward completion as rapidly as possible.

The river still being above a medium stage, and the decline very gradual, work advanced for a time in from 20 to 24 feet of water and a rapid current. When the hurdle had crossed the channel the construction was less difficult, and work advanced without further annoyance save from sickness and scarcity of labor.

The same forms of construction described in my annual report for the last fiscal year were used. For a distance of 1,550 feet from the shore the hurdle was a combination of the curtain and fixed hurdle, the curtains being placed in depths of water greater than 10 feet and brought to the surface. From the surface of the water to a 20-foot stage of the river the hurdle is of the fixed type, as is also the remaining half of the hurdle beyond this point.

The mattress is of the same form throughout. That portion 2,000 feet in length across the channel in deep water and strong current is composed of three courses of brush, the remainder of two courses, built in sections 130 feet in length by 50 feet in width.

PILE-DRIVING.

In the main the piles have been driven butts down, by means of jet and hammer combined, the exception being that of repairing destroyed portions of the hurdle where the piles were driven through the footing mattress, in which case they were driven tops down, the hammer alone being used.

Careful observations have been taken of this work to ascertain the comparative utility of hard and soft wood piles.

For a time it was maintained by the foremen of pile-drivers, first, that hard-wood piles could be driven deeper than soft-wood; second, that a greater number of piles could be driven in a given time; and third, that they were much more stable when driven. The work of the season, however, has proven that the first two assertions were products of delusion.

The stability of hard-wood piles is acceded. Their superior strength renders them adaptable to construction where excessive strains are to be borne, when their use may be adopted, even at a much greater first cost.

Below is shown the work of pile-drivers for the half year:

Working time	hours..	571
Number of piles driven		603
Average depth driven	feet..	11.78
Average depth of water	do..	16.00
Number of piles driven per hour		1.06
Number of feet driven per hour	feet..	12.44

The work of construction for the half year is as follows:

Hurdle constructed (including repairs), 2,670 linear feet, 46,400 square feet.
Footing mattress, 2,550 linear feet, 127,500 square feet.

In which were expended—

Brush	cords..	1,528.35
Stone	cubic yards..	1,145.15
Piles		929
Bolts		454
Iron	pounds..	3,826
Nails	do..	200
Rope	do..	2,162
Spikes	do..	345
Wire	do..	4,600
Lumber	feet..	575

With this work the primary hurdle was completed October 20, its total length being 3,100 feet.

MINTON POINT.

No work done and none needed. The works remain substantially in the same condition as at the close of the fiscal year last preceding.

CONCLUSION.

Upon the completion of the primary hurdle opposite Cape Girardeau improvements in this locality were abandoned, they having amply performed their proposed work in securing a good harbor at Cape Girardeau and a 15-foot channel at a 9.5-foot stage of water, the entire stretch of river over 4 miles in length, from the head of the works above Minton Point to and past the city of Cape Girardeau.

Accompanying this report is a map showing the extent of the works in good order and the condition of the river at the close of operations. YH 30088

Very respectfully, your obedient servant,

J. A. WORTHEN,
Resident Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

T 5.

IMPROVEMENT OF OSAGE RIVER IN KANSAS AND MISSOURI.

Work during the year consisted mainly in removing snags from the channel and overhanging trees from the bank. At Moore's Flats the shore was protected for a length of about 250 feet, and some small repairs were made to the training walls at Dixon's and Round Bottom shoals.

At the beginning of the year a force was engaged at this work, and so continued until August 3, when it was disbanded. Up to that time two hundred and twenty-eight snags and twenty-three overhanging trees had been removed since July 1 between Big Gravois and the mouth of the Osage, a distance of 82 miles. The river had thus been well cleared of these obstructions for the entire length of about 176 miles below Grand River. Nothing had been done between Grand River and Osceola, the head of navigation, a distance of about 54 miles; but on account of low water it was not possible to reach that part of the river with a steamboat during the summer and autumn. The work was resumed in April, and was carried on at first over the part between Osceola and Grand River, in which one hundred and thirty-eight snags and five hundred and forty-nine trees were removed. It was then continued to the mouth of the Osage, going over the same ground that had been covered before. In this part eighty-five snags and two hundred and eleven trees were removed.

The work was under the immediate direction of Overseer Kimbrough Winston, whose report is hereto appended, marked 21. Attention is invited to this report for details of the work, and for a statement of the commerce of the Osage River for the fiscal year.

The gauges at Tuscumbia and Warsaw were read daily. Their records are hereto appended, marked 22 and 23 respectively.

The expenditures were \$9,873.43, leaving an available balance of former appropriations of \$1,660.65. Most of this will be consumed in caring for the public property and in keeping the gauges. A new supply of snags and overhanging trees is to be expected in the future, but how rapidly they will accumulate is a matter of conjecture.

It is thought that an appropriation of \$5,000 will be sufficient to accomplish all that may be required during the year ending June 30, 1885.

Money statement.

July 1, 1882, amount available.....	\$11,488 51
Miscellaneous receipts	45 57
	<hr/> 11 534 08
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$9,823 56
July 1, 1883, outstanding liabilities	49 87
	<hr/> 9,873 43
July 1, 1883, amount available.....	1,660 65
Amount that can be profitably expended in fiscal year ending June 30, 1885.	<hr/> 5,000 00

21.

REPORT OF MR. KIMBROUGH WINSTON, OVERSEER.

JEFFERSON CITY, MO., July 6, 1883.

MAJOR: I have the honor to submit the following report of operations for the improvement of the Osage River for the fiscal year ending June 30, 1883.

The work done during the first six months was a continuation of that in progress June 30, 1882, and consisted in the removal of snags from the channel and overhanging trees from the banks of the river at the different shoals between and including Big Gravois Shoal and the mouth of the river. It also included the revetting of some 250 feet of the right hand shore at Moore's Flats, and the repair of a small break in the training walls at Dixon's and Round Bottom Shoals. Between Big Gravois and the mouth of the river two hundred and twenty-eight snags were removed from the channel and twenty-three overhanging trees cut and removed from the banks.

At Moore's Flats 350 cubic yards of stone and 50 cords of brush were used in revetting the shore.

At Dixon's Shoal a break or low place in the training wall was closed, requiring the use of 15 cubic yards of stone, and at Round Bottom a similar gap in the training wall was closed, requiring some 18 cubic yards of stone. This work was finished on the 3rd of August, the boat, barges, and all other property removed to Osage City, where the public property was placed in charge of a watchman, and the steamboat and all laborers discharged.

By instructions from you, dated August 10, I was directed to assume charge of the public property and improvement of the Osage River, relieving Assistant Engineer W. S. Simpson, who had charge of the work up to this time, and on the 14th of the same month received your verbal order to make an examination of and to take soundings on all the shoals between Tuscumbia and the mouth of the river. This examination was completed September 2, and a report of the same submitted to you.

No other work than that necessary to protect and care for the public property was done until the 14th of April, when I received orders from you to make preparations for removing the snags and overhanging trees upon the Osage River, between Osceola and Grand River, where the work was terminated last year, and to repeat so much of it as might be necessary between grand River and the mouth of the Osage.

On the 19th, all preparations being completed, and the services of the steamer Emma secured (as also directed) upon the same terms as those of last year, I left Osage City and arrived at Davison's Island—the first shoal above Grand River—the evening of the 30th. The progress of the boat had been very slow and tedious, as the river was unusually low for the season of the year. The boat was frequently aground, and had to be sparred and pulled over a large majority of the shoals between Tuscumbia and Grand River. Owing to the low stage of water, I deemed it best upon my arrival at Davison's Island to commence work at that point and remove all obstructing snags and trees as I proceeded toward Osceola, as in many places it would have been impossible to proceed until at least a part of the obstructions were removed.

On the 14th of May, when within some 12 miles of Osceola, the river commenced to rise, and fearing that the snags, which were only exposed in low water, would be too deeply immersed to show when I reached them in the regular progress of the work, I ran to Osceola the next day with the boat, noting and locating the snags that needed removing as I went up, and commenced work at the first shoal below Osceola and continued working down-stream until I reached the point where work had been suspended at the commencement of the rise. In this way the snags were all removed.

Those which were too deep in the water after the rise to show any break were found by dragging a heavy chain along the bottom of the channel.

The distance from Grand River to Osceola is about 70 miles, and there are twenty-six shoals at which it was found necessary to do more or less work, some requiring days to remove all obstructions, others only a few hours. Nearly all of this work was done during a very low stage of water and was very thorough and complete, and will doubtless be quite beneficial to the raft navigation of the river (boats only ply on this part of the river in high water). The country along and adjacent to this part of the river is still finely timbered and large quantities of logs and railroad ties are rafted to Warsaw and Osage City.

On the 22d of May this part of the work was finished, and on the 23d I began to repeat the work of last season wherever found necessary between Grand River and the mouth of the Osage. On this portion of the river, in nearly every instance where it was found necessary to do any work, the banks are high and have given way during high water, carrying with them trees and the stumps of those cut away in former seasons, and rendering it necessary to again clear the banks of the leaning timber and the channel of the fallen trees and stumps. This work was completed on the 7th of June, and the total number of snags and trees removed between Osceola and the mouth is two hundred and twenty-three of the former and seven hundred and sixty of the latter; one hundred and thirty-eight snags and five hundred and forty-nine trees were removed from the river between Grand River and Osceola; the remainder eighty-five snags and two hundred and eleven trees from that part reaching from Grand River to the mouth of the Osage.

On the 11th of June, in obedience to the instructions contained in your letter of May 30, all public property for which I was responsible was loaded on the barge and quarter-boat and the whole towed by the steamer Emma to the Engineer Depot at Saint Louis, and transferred to Mr. C. L. Stevenson.

Upon the return of steamer Emma to Osage City, June 30, the steamer and all employees were discharged.

Following is a statement of the commerce on the Osage River during the fiscal year just ended:

637,500 railroad ties, rafted	\$191,250
641,000 feet of oak logs, rafted.....	12,820
293,000 feet of walnut, rafted.....	11,720
108,000 feet of walnut lumber, boated	5,400
86,300 feet of pine lumber, boated.....	1,720
530,932 bushels of wheat	530,932
94 tons of barytes.....	3,760
5,709 tons of miscellaneous freight, value unknown.	

Very respectfully, your obedient servant,

KIM. WINSTON,
United States Overseer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

22.

Record of gauge at Tusculumbia, Mo., for the fiscal year ending June 30, 1883.

Day.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
1	8.15	1.25	0.20	0.55	1.15	1.75	2.30	2.90	14.25	3.10	1.65	5.55
2	7.00	1.40	0.30	0.50	1.75	1.70	2.15	3.30	12.25	3.05	1.50	4.85
3	5.40	1.70	0.30	0.35	1.00	1.70	2.10	3.50	10.75	3.00	1.40	4.30
4	5.05	4.65	0.20	0.25	0.80	1.65	2.00	3.20	9.50	3.00	1.30	4.00
5	4.50	3.70	0.15	0.20	0.85	1.60	1.90	4.45	8.25	2.90	1.60	3.90
6	3.45	2.55	0.10	0.15	0.90	1.55	1.75	4.50	7.30	2.90	1.55	4.10
7	3.05	2.20	0.10	0.10	0.95	1.50	1.55	4.30	7.00	2.85	1.70	5.00
8	2.80	1.90	0.10	0.05	1.00	1.50	1.55	3.90	7.00	2.75	1.75	5.40
9	2.50	1.70	0.10	0.20	1.20	1.50	1.95	2.70	7.25	2.75	1.90	4.60
10	2.90	1.40	0.10	0.60	1.30	1.50	2.10	3.45	7.40	2.70	2.10	4.30
11	2.50	1.15	0.05	0.60	1.55	1.45	2.10	3.35	6.60	3.05	2.25	4.20
12	2.30	1.00	0.00	0.50	1.90	1.40	1.95	3.10	5.75	3.00	2.10	5.65
13	2.10	0.90	-0.05	0.50	2.60	1.40	1.90	3.15	5.25	2.90	2.10	12.70
14	1.95	0.80	-0.10	0.45	2.60	1.35	1.90	3.00	4.75	2.80	2.00	18.50

1296 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Record of gauge at Tuscomb, Mo., for the fiscal year ended June 30, 1883—Contd

Day.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.
	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>
15	2.45	0.75	-0.10	0.75	3.85	1.30	1.80	22.00	4.40	2.60	5.70
16	2.53	0.70	-0.15	0.80	3.90	1.25	1.75	25.50	4.10	2.50	7.00
17	2.70	0.70	-0.15	1.00	4.05	1.15	1.75	28.25	3.80	2.40	8.30
18	4.20	0.80	-0.20	0.80	4.80	1.10	1.75	29.00	3.60	2.35	9.25
19	4.45	0.55	-0.25	0.80	5.35	1.10	1.75	27.00	3.60	2.30	9.60
20	4.45	0.50	-0.20	0.70	5.85	1.20	1.80	23.50	3.45	2.20	10.15
21	4.45	0.45	-0.20	0.60	6.70	1.55	1.80	20.00	3.25	2.10	10.80
22	4.55	0.40	-0.20	0.60	7.40	1.85	2.10	17.50	3.10	2.10	11.50
23	4.60	0.35	-0.20	0.55	8.25	1.80	2.15	16.00	2.90	2.05	11.60
24	4.55	0.30	-0.20	0.50	9.10	1.80	2.25	15.00	2.75	2.00	10.40
25	4.65	0.30	-0.20	0.45	10.00	2.00	2.40	13.00	2.60	1.95	8.65
26	4.70	0.30	-0.25	0.55	11.00	2.30	2.70	10.50	2.40	1.90	8.40
27	1.60	0.30	-0.25	0.65	1.85	2.65	2.90	18.50	2.35	1.85	8.15
28	1.50	0.25	-0.25	0.65	1.90	2.70	3.00	10.75	2.35	1.85	8.80
29	1.35	0.20	+0.50	0.55	1.80	2.85	3.00		2.35	1.80	9.10
30	1.55	0.20	0.55	0.45	1.75	2.55	2.25		3.00	1.80	7.75
31	1.45	0.15		0.60		2.45	2.80		3.10		6.60

Navigation suspended on account of ice January 2 to February 14.

23.

Record of gauge at Warsaw, Mo., for the fiscal year ending June 30, 1883.

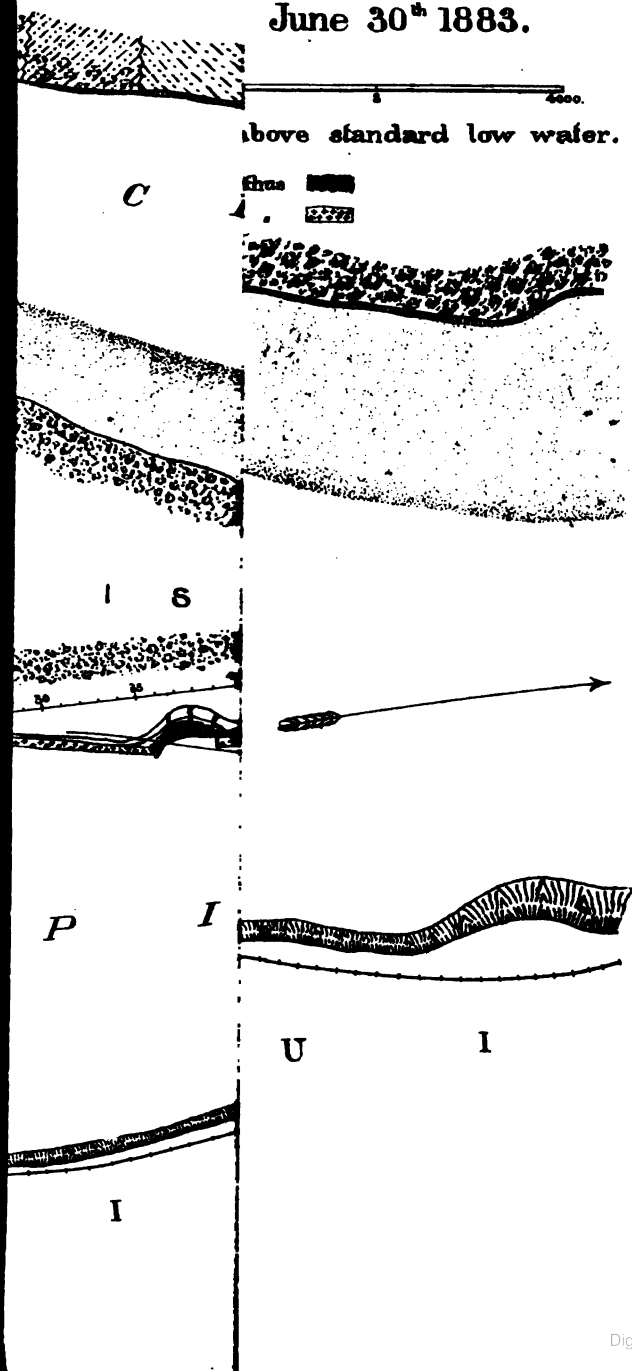
Day.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.
	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>
1	3.60	1.20	0.10	0.10	0.60	1.50	1.80	1.80	10.20	3.00	1.30
2	2.40	4.00	0.10	0.10	0.80	1.50	1.70	2.00	8.00	2.80	1.30
3	2.20	2.50	0.00	0.00	1.00	1.50	1.60	2.00	7.40	2.60	1.20
4	2.00	2.20	0.00	0.00	0.80	1.40	1.50	2.10	5.00	2.00	1.20
5	1.80	1.80	0.00	0.40	0.70	1.40	1.50	2.10	4.70	2.00	1.40
6	1.60	1.60	0.00	0.70	0.80	1.40	1.40	2.00	4.50	2.00	1.60
7	1.50	1.40	0.00	1.10	0.90	1.30	1.40	2.00	4.30	2.00	1.60
8	1.40	1.30	0.00	0.80	1.00	1.30	1.40	2.00	4.20	2.20	1.80
9	1.30	1.20	0.00	0.80	1.00	1.20	1.40	2.00	4.10	2.20	2.00
10	1.20	1.10	0.00	0.70	1.20	1.20	1.40	2.00	4.00	2.10	2.00
11	1.10	1.00	0.00	0.60	1.70	1.20	1.40	2.00	3.90	2.10	1.80
12	1.00	0.90	-0.10	0.60	2.50	1.20	1.40	1.90	3.80	2.00	2.00
13	1.00	0.80	-0.10	0.70	2.70	1.20	1.50	1.80	3.80	2.00	4.10
14	1.40	0.80	-0.20	0.80	2.80	1.20	1.50	19.50	3.70	1.90	5.60
15	2.00	0.70	-0.20	0.80	3.20	1.00	1.50	26.50	3.70	1.80	6.80
16	3.50	0.60	-0.30	0.80	2.80	1.00	1.40	28.00	3.60	1.80	7.40
17	3.80	0.50	-0.30	0.60	2.50	1.00	1.40	28.00	3.60	1.70	8.00
18	4.40	0.50	-0.30	0.40	2.30	1.00	1.40	23.00	3.50	1.70	9.00
19	5.00	0.40	-0.30	0.20	2.20	1.00	1.40	19.70	3.40	1.60	9.70
20	3.80	0.40	-0.30	0.20	2.20	1.00	1.30	18.00	3.40	1.60	10.50
21	3.00	0.40	-0.40	0.40	2.00	1.00	1.30	17.00	3.30	1.50	11.20
22	2.40	0.40	-0.40	0.80	1.90	0.90	1.30	16.60	3.30	1.50	10.30
23	2.00	0.40	-0.40	0.80	1.80	0.80	1.30	16.40	3.20	1.50	8.30
24	1.70	0.40	+1.00	0.70	1.70	1.00	1.30	18.00	3.10	1.50	6.00
25	1.50	0.30	1.00	0.60	1.70	1.70	1.30	18.60	3.10	1.50	4.80
26	1.40	0.30	0.80	0.50	1.60	2.10	1.30	17.00	3.00	1.40	7.20
27	1.30	0.30	0.60	0.40	1.60	2.10	1.30	14.70	3.00	1.40	7.00
28	1.20	0.30	0.40	0.40	1.60	2.00	1.30	12.00	3.00	1.40	6.80
29	1.10	0.30	0.30	0.40	1.60	2.00	1.30		3.00	1.30	6.00
30	1.00	0.20	0.20	0.40	1.50	1.90	1.50		3.00	1.30	5.00
31	1.00	0.20		0.40		1.80	1.60		3.00		3.90

Navigation suspended on account of ice January 2 to February 14.

UTE

ROTECTION.

June 30th 1883.



APPENDIX U.

REMOVING SNAGS AND WRECKS FROM THE MISSISSIPPI AND MISSOURI RIVERS—IMPROVEMENTS AT VARIOUS POINTS ON MISSOURI RIVER—SURVEY OF MISSOURI RIVER FROM ITS MOUTH TO FORT BENTON—IMPROVEMENT OF GASCONADE RIVER, MISSOURI.

REPORT OF MAJOR CHARLES R. SUTER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|--|---|
| 1. Removing snags and wrecks from the Mississippi and Missouri rivers. | 10. Missouri River at Atchison, Kans. |
| 2. Missouri River between Kansas City and its mouth. | 11. Missouri River at Saint Joseph, Mo. |
| 3. Missouri River from its mouth to Sioux City, Iowa, &c. | 12. Missouri River at Brownville, Nebr. |
| 4. Missouri River at Saint Charles, Mo. | 13. Missouri River at Eastport, Iowa, and Nebraska City, Nebr. |
| 5. Missouri River at Cedar City, Mo. | 14. Missouri River at Plattsmouth, Nebr. |
| 6. Missouri River at Glasgow, Mo. | 15. Missouri River at Council Bluffs, Iowa, and Omaha, Nebr. |
| 7. Missouri River at Lexington, Mo. | 16. Missouri River at Sioux City, Iowa. |
| 8. Missouri River at Kansas City, Mo. | 17. Missouri River at Vermillion, Dak. |
| 9. Missouri River at Fort Leavenworth, Kans. | 18. Survey of Missouri River from its mouth to Fort Benton, Mont. |
| | 19. Gasconade River, Missouri. |

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., August 13, 1883.

GENERAL: I have the honor to submit the following annual report on the works under my charge during the fiscal year ending June 30, 1883.

Very respectfully, your obedient servant,

CHAS. R. SUTER,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

U I.

REMOVING SNAGS AND WRECKS FROM MISSISSIPPI AND MISSOURI RIVERS.

On this work the three large snag-boats J. N. Macomb, H. G. Wright, and R. E. De Russy were almost continuously employed. Owing to the late passage of the river and harbor act, nothing was done till August 15, at which date all three boats were put at work, the Wright in the Missouri, the De Russy in the Mississippi between Cairo and the mouth of the Missouri, and the Macomb in the Lower Mississippi. Later in the season the Wright worked in the Mississippi between Cairo and Memphis, the De Russy between Memphis and White River, and the Macomb between White River and Vicksburg, and all three were kept

at work till the rising river compelled me to suspend operations. In the spring the Wright and Macomb both worked in the Missouri River as long as the stage of water would allow.

On the Missouri but little could be done last fall, owing to the extremely low stage of water, but during the spring operations the river was put in very satisfactory condition. On the Mississippi the work was very thorough and complete, and the river was kept in better condition than had for years been possible, owing to lack of funds.

MISSISSIPPI RIVER.

Work on this stream extended from the mouth of the Missouri to Glasscock's Island, a distance of 1,000 miles. All three boats were employed, and their aggregate period of service was sixteen and a half months.

The snag-boat Macomb left Mound City August 15, 1882, and worked down the Mississippi as far as Glasscock's Island. She started back on September 17, 1882, and had reached Cairo on October 21, 1882. Returning down the river she reached Vicksburg on December 4, 1882. From that date till February 9, 1883, she worked between Vicksburg and the mouth of White River, passing over the river several times, and devoting special attention to the vicinity of Island No. 93, which was very troublesome during the season. February 9, 1883, she started up the river snagging as far as Memphis. Between that point and Cairo the river was too high to do any work, and the crew devoted their time to rescuing people and live stock who were isolated by the great flood. On the 28th of February, 1883, she reached Saint Louis and was laid up temporarily, having been continuously at work for six and a half months.

The snag-boat De Russy began work at Saint Louis August 15, 1882, and had worked down to Cairo by the 26th. She was engaged in the neighborhood of Cairo till September 7, 1882, and then worked up to Madison, Ill., opposite the mouth of the Missouri. From this point she turned back October 3, 1882, and had reached Cairo by the 20th. Between this date and November 6, 1882, she worked up to Fairy Island and back to Cairo, then returned to Madison and was back at Cairo by December 2, 1882. As the ice in the upper river had now about stopped navigation, she was ordered below Cairo and worked between Memphis and White River till February 12, 1883. She was then ordered in and was laid up at Saint Louis on March 1, after six and a half months' continuous service.

The snag-boat Wright, after leaving the Missouri River November 15, 1882, was ordered below Cairo to work between that point and Memphis. She was kept on this beat till the middle of February, when, on account of the high water, she was ordered in. She reached Saint Louis and was laid up temporarily on February 28, 1883.

Table of work done in Mississippi River.

Names of boats.	No. of snags pulled.	Weight in tons of 2,000 pounds.	No. of trees cut.	No. of drift piles removed.	No. of miles run.
J. N. Macomb	1, 240	16, 255. 5	6, 505	13	4, 666
R. E. De Russy	1, 188	36, 869. 5	7, 720	14	2, 774
H. G. Wright	347	8, 930. 7	12, 072	4	1, 532
	2, 775	62, 055. 7	26, 297	31	8, 972

ESTIMATES.

For repairing one wooden snag-boat and fitting it up for wrecking purposes. \$50,000
 For working expenses of three boats, ten months each, at \$4,000 per month.. 120,000

Total 170,000

Money statement.

July 1, 1882, amount available..... \$3,812 18
 Amount received from sales of fuel to officers..... 19 12
 Amount appropriated by act passed August 2, 1882 85,000 00

..... 88,831 30
 July 1, 1883, amount expended during fiscal year, exclusive of outstanding
 liabilities July 1, 1882..... 69,540 59

July 1, 1883, amount available..... 19,290 71

Amount that can be profitably expended in fiscal year ending June 30, 1885. 170,000 00

MISSOURI RIVER.

Operations in this stream extended from the mouth to Kansas City, Mo., a distance of 375 miles. The whole distance was worked over twice, the lower half four times, the snag-boats Wright and Macomb being employed. Their aggregate time of service was six months.

The snag-boat Wright left Saint Louis August 13, 1882, and by September 30, 1882, had reached Brunswick, 257 miles from the mouth. The river was then so low that all navigation was suspended, and it was not deemed advisable to go any higher. She therefore worked down the river till November 15, 1882, when she was withdrawn and ordered to the Mississippi. During the course of this exceedingly difficult season's work the hull of the boat was repeatedly and extensively injured, but in all cases the damage was repaired by the crew without leaving the field. March 18, 1883, the boat was again ordered to the Missouri with orders to work between Boonville and Kansas City. She reached Boonville on the 23d, and Kansas City April 13, 1883. Returning she reached Boonville on the 25th and Saint Louis on the 28th, when she was laid up for repairs after an arduous season's work of eight months.

The snag-boat Macomb was ordered to the Missouri on March 17, with orders to work between the mouth and Boonville. She was engaged on this duty till April 25, 1883, when she was withdrawn and laid up at Saint Louis for repairs. Her service for the year aggregated eight months.

Table of work done in Missouri River.

Names of boats.	No. of snags pulled.	Weight in tons of 2,000 pounds.	No. of trees cut.	No. of drift piles removed.	No. of miles run.
E. G. Wright	1,040	15,295.5	3,728	7	1,461
J. N. Macomb	223	2,814.4	701	4	407
Total	1,263	18,109.9	4,429	11	1,868

1300 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Recapitulation of work done during the fiscal year ending June 30, 1883.

Names of rivers.	No. of snags pulled.	Weight in tons of 2,000 pounds.	No. of trees cut.	No. of drift piles removed.	No. of miles run.
Mississippi	2,775	62,055.7	26,297	31	8,599
Missouri	1,263	18,106.9	4,439	11	1,866
Total	4,037	80,165.6	30,726	42	10,707

ESTIMATES.

For building light-draught snag-boat	\$80,000
For operating three boats, nine months each, at \$4,000 per month	108,000
Total	188,000

Money statement.

July 1, 1882, amount available	\$80,000 00
Amount appropriated by act passed August 2, 1882	65,000 00
	145,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	46,661 35
July 1, 1883, amount available	98,338 65
Amount that can be profitably expended in fiscal year ending June 30, 1885.	188,000 00

CONSTRUCTION OF NEW BOATS.

During the last season's operations some modifications in the construction of the snag-boat hulls were suggested which rendered necessary a revision of the design for the new snag-boat ordered for the Missouri River. This work is about finished, and it is hoped to construct the hull during the present season.

I have also been engaged on the plans for a stern-wheel snag-boat for Missouri, and the estimate of \$80,000 is herewith submitted and recommended for this purpose, as also an estimate of \$50,000 for repairing the old wooden snag-boat *De Russey*, which, after fifteen years' hard service, is worn out. She should be fitted up especially to remove wrecks, of which there are a vast number, constituting serious obstacles to navigation.

OPERATIONS FOR THE COMING SEASON.

The failure of the river and harbor bill was very unfortunate for this work. The thorough work of last season had placed the rivers in excellent condition, and they could easily have been kept so if the funds had been available. As it is, however, the small balance from last year's appropriation will only admit of six months' work, of which three will go to the Mississippi and three to the Missouri.

The work is situated in the collection district of New Orleans.

The amount of revenue collected at the port of Saint Louis, Mo., during the fiscal year ending June 30, 1883, was \$1,393,744.56.

The commerce benefited by the work is that of the entire Mississippi Valley.

U 2.

IMPROVEMENT OF MISSOURI RIVER FROM KANSAS CITY TO ITS MOUTH.

Operations under this head consisted only of snagging. During the present season this work has been carried on under the regular snag-boat appropriation and is described under that head.

Money statement.

July 1, 1882, amount available	\$566 43
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	556 43

U 3.

IMPROVEMENT OF MISSOURI RIVER FROM ITS MOUTH TO SIOUX CITY, IOWA, ETC.

In my last annual report there was outlined the general project for commencing this work. It was proposed first to procure as soon as possible the plant required for its prosecution; this to be made as complete and as perfect in all respects as our own experience and that of others might render possible. Second, to concentrate the work as far as possible confining the operations outside of the general work to such points as seemed most important or where a moderate allotment would apparently enable results of permanence and value to be obtained. Third, to begin the general improvement upon a limited extent of river and to carry this work to completion before undertaking to extend it.

The portion of river selected for commencing this work extends from Charleston, Kans., to Lexington, Mo., a distance of 186 miles, and embraces five of the special localities where work had heretofore been in progress under specific appropriations. This reach was to be divided into three divisions, each with a complete engineering staff, the chief of which was to be authorized to form as many subdivisions as necessary, each subdivision being complete in itself and fully equipped for work.

The localities selected for allotments from the general fund were Saint Charles and Glasgow, Mo.; Nebraska City and Omaha, Nebr., and Sioux City, Iowa. Cedar City, Mo., Brownville and Plattsmouth, Nebr., were to be discontinued for the reasons previously given.

The general allotment of the appropriation was as follows:

General improvement	\$330,000
Purchase of new plant and repair of old	400,000
Saint Charles, Mo., work of improvement	22,000
Glasgow, Mo., work of improvement	30,000
Nebraska City, Nebr., work of improvement	33,000
Omaha, Nebr., work of improvement	20,000
Sioux City, Iowa, work of improvement	15,000
Total	850,000

This project having been approved, work was begun as soon as the old plant could be put in shape for use, and has been in progress ever since. The only modifications in the original allotments have been as follows: From the allotment for general improvements \$6,000 was allotted for a survey from Lexington to Boonville; from the allotment for Glasgow, \$25,881.38 was transferred to Saint Charles, and from the allotment for Sioux City, \$2,832.42 was transferred to Nebraska City. Operations under the various allotments are described under their respective heads.

SAINT CHARLES, MISSOURI.

The work proposed at this locality was intended to preserve the present status of affairs till this point could be reached in the general improvement, and consisted generally of an attempt to close the slough behind Saint Charles Island, the revetment of the upper portion of Saint Charles Bend, while the lower portion was to be protected by deflecting dikes designed to throw the water out of this portion of the bend and higher up on the Saint Charles landing. The work was begun late in the season, Assistant F. M. Harris being in charge, and was persevered in under many difficulties till prematurely stopped by the advent of freezing weather. The works in the slough consisted of a pile dike with a mattress sill extending between high-water lines. The work in the bend consisted of pile deflecting dikes and of about 1,000 feet of revetment. This latter had not been connected with the dikes when work stopped and was not completed in other respects, especially with regard to a stone covering to the slope above high water. The break up of ice in the spring was the most severe we have ever experienced and proved most disastrous to the work. The dike across the slough and the pile dikes in the bend were carried away entirely, while the revetment was so cut and torn away as to require entire renewal. Under these circumstances it was recommended to you that the balance of the Glasgow allotment, where but little work had been done, and where no pressing necessity existed, should be transferred to Saint Charles. This recommendation having been approved, Assistant S. W. Fox was put in charge of the work, which he has prosecuted with much vigor and success. A total length of 2,250 feet has been substantially revetted and has stood successfully the highest and most long-continued flood since 1844. The rock covering was stopped by the advent of this flood, but will be completed as soon as the river falls sufficiently.

As the state of our funds will not justify any further allotment the work must then stop, although the erosion in the lower part of the bend still continues and is likely to do so. The plant and other property will be taken to Kansas City, where it can be utilized and cared for.

The reports of Assistants Harris and Fox are appended.

Money statement.

Amount allotted from general appropriation	\$22,000 00
Amount transferred of allotment for Glasgow	25,881 38
	<hr/> 47,881 38
July 1, 1883, amount expended during fiscal year	\$40,314 24
July 1, 1883, outstanding liabilities.....	24 00
	<hr/> 40,338 24
July 1, 1883, amount available.....	7,543 14

GLASGOW, MISSOURI.

Owing to the inadequate supply of plant, it was decided to defer till spring the revetment work contemplated at this point. All necessary preparations had been made for this purpose, but the disaster at Saint Charles and the fact that certain channel changes had removed the pressing necessity for action at Glasgow decided me to recommend the transfer of the balance of the allotment to Saint Charles. Assistant S. W. Fox, who had been in charge at Glasgow, was ordered to the charge of the Saint Charles work, and all the plant was transferred to the same locality.

Money statement.

Amount allotted from general appropriation	\$30,000 00
July 1, 1883, amount expended during fiscal year	\$4,118 62
Amount transferred to Saint Charles	25,881 38
	<hr/> 30,000 00

NEBRASKA CITY, NEBRASKA.

Work contemplated at this point was the construction of a good revetment on the upper side of the point at Eastport, opposite Nebraska City. The plant from Plattsmouth and a portion of that from Omaha was transferred to this place, the work being in charge of Assistant A. S. Potter. There has been constructed 5,160 feet of substantial revetment, which will, however, require considerable rock to complete it, and the work must be considerably extended. This is not possible with our present means. The plant and other property has been transferred to Saint Joseph since the closure of work. Assistant Potter's report is appended.

Money statement.

Amount allotted from general appropriation	\$33,000 00
Amount transferred of allotment for Sioux City	2,832 42
	<hr/> 35,832 42
July 1, 1883, amount expended during fiscal year	32,326 23
July 1, 1883, amount available	<hr/> 3,506 19

OMAHA, NEBRASKA.

All that seemed immediately necessary at this point was to reinforce and extend the Omaha revetment, and an allotment was made for that purpose, Assistant U. S. Pease being placed in charge of the work. During the fall some repairs were made to the revetment and a set of discharge measurements taken at Florence. During the current season it is proposed to extend the Omaha revetment.

Money statement.

Amount allotted from general appropriation	\$20,000 00
July 1, 1883, amount expended during fiscal year	\$7,819 75
July 1, 1883, outstanding liabilities	264 00
	<hr/> 8,083 75
July 1, 1883, amount available	<hr/> 11,916 25

SIOUX CITY, IOWA.

The training-dike built during the previous season had given such good results that it was thought advisable to extend it, and an allotment was made for the purpose, Assistant C. F. Potter being placed in charge of the work. Work was carried on during the latter part of the fall with every prospect of success, but during the heavy ice break-up the dike was entirely destroyed. The balance of the allotment was not sufficient to replace it, and on my recommendation was transferred to Nebraska City, the plant and other property being sent to Saint Joseph. The report of Assistant Potter is appended.

Money statement.

Amount allotted from general appropriation	\$15,000 00
July 1, 1883, amount expended during fiscal year	\$12,167 58
Amount transferred to Nebraska City	2,832 42
	<hr/> 15,000 00

SURVEY OF MISSOURI RIVER FROM LEXINGTON TO BOONVILLE.

A resurvey of this portion of the river being deemed important for comparison with Captain Wellman's survey of 1878, an allotment was made for the purpose and the work put in charge of Assistant S. W. Fox. The work was carried to completion during the fall and has since been partly mapped for reference.

Money statement.

Amount allotted of allotment for general improvement	\$6,000 00
July 1, 1883, amount expended during fiscal year	6,000 00

CONSTRUCTION AND REPAIR OF PLANT.

The repair of the old plant was an unavoidable necessity, although it was known that its utility would generally be very questionable when operations on the large scale contemplated should be inaugurated. Still, as it was deemed necessary to begin work at once, and as the procuring of the new plant would be a work of some time, no other course was left open. As had been anticipated, the cost has been great and the results unsatisfactory, the expense of the various works undertaken having been greatly enhanced by the imperfections in the working appliances.

The new plant deemed necessary having been decided on, steps were at once taken for procuring it. Unfortunately the great floods in the Ohio during the winter and spring greatly delayed the completion of the boats required, so that no opportunity has been afforded of testing the various appliances. All the barges and most of the boats have been delivered and the erection of machinery and special appliances is in progress. Detailed description of the plant is postponed till after its trial, but the principal items are as follows:

Barges, 100 by 25 feet, for carrying brush or stone	35
Barges, 64 by 16 feet, for general use	31
Mattress boats for making revetment 90 feet wide	6
Hydraulic graders, with quarters for crew	6
Quarter boats for 120 men each	6
Hydraulic pile-sinkers, with quarters for crew	15
Floating machine-shop, with iron-working tools	1
Yawls	27
Skiffs	60
Tow-boat	1

Through the courtesy of Majors Mackenzie and Ernst, United States Engineers, I secured the use in the latter part of the season of the tow-boats Coal Bluff and A. A. Humphreys, and also of four barges for temporary use at Saint Charles, Mo.

The new plant will be completed early in the coming season, and will exhaust the allotment.

Money statement.

Amount allotted from general appropriation	\$400,000 00
July 1, 1883, amount expended during fiscal year	\$311,728 11
July 1, 1883, outstanding liabilities	71,596 67
	<hr/> 383,324 78
July 1, 1883, amount available	16,675 22

GENERAL IMPROVEMENT.

The reach selected was formed into three divisions of about 60 miles each, designated as those of Saint Joseph, Leavenworth, and Kansas City, from their respective headquarters, and these were placed in charge of Assistants D. W. Church, S. H. Yonge, and J. W. Nier, in the order named.

The Saint Joseph division extended from Charleston, Kans., to the Atchison Bridge, the Leavenworth division from the Atchison Bridge to the Kaw River, and the Kansas City division from this point to Lexington. After the failure of the river and harbor bill, the Leavenworth and Kansas City divisions were consolidated under the charge of Assistant Yonge.

KANSAS CITY DIVISION.

The work done on this division consisted mainly of revetment work on the left bank of the river, opposite Lexington, Mo. The work was begun late in the fall, and was prosecuted through the winter and spring till the high water caused a suspension of operations. The work consisting of 4,200 feet of bank revetment, although incomplete, stood the ice break-up very well, as also the subsequent great floods. It is expected that it will be substantially completed during the present season.

In addition to this work, a thorough survey of the river was made within the limits of the division, and the results have been platted for reference.

LEAVENWORTH DIVISION.

The work in this division consists mainly of revetment work on the left bank of the Missouri in Kaw Bend, just above Kansas City. Work was begun in the fall and prosecuted as opportunity offered during the winter and spring. In all, 8,750 feet of very substantial revetment has been placed, and about 10,000 feet more are required. In addition, a thorough survey has been made of the river within the limits of the division, and discharge observations are in progress at Kansas City.

Extensive rectification works had been projected above Fort Leavenworth, but the small balance remaining available will probably not allow of their inception during the present season.

SAINT JOSEPH DIVISION.

The work done in this division is located at Saint Joseph and Atchison.

At Saint Joseph efforts were directed to repairing and extending the Elwood revetment, opposite the town, which had been much damaged by the destruction of the bridge company's dikes during the flood of 1881. About 4,100 feet of revetment have been placed, which will meet the immediate danger, though its ultimate extension to Belmont is deemed essential, as also the extension of the revetment on the upper side of the French Bottom, above Saint Joseph. This work will be carried as far as possible during the coming season.

At Atchison a number of pile-sinkers were collected from different works, and some training dikes constructed in the spring. The immediate object sought was to protect the left bank above the bridge, to direct the channel more fairly through the draw, and to close the chute above the town. These works were suspended during the high water, but the general results so far apparent seem to be good.

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A survey has been made of the river within the limits of the division, and a series of discharge observations were taken at Atchison.

The reports of assistants J. W. Nier, S. H. Yonge, and D. W. Church, in charge of the three divisions, are herewith appended.

Money statement.

Amount allotted from general appropriation	\$330,000 00
Amount allotted for survey from Lexington to Boonville ...	\$6,000 00
July 1, 1883, amount expended during fiscal year	192,496 06
July 1, 1883, outstanding liabilities	21,042 52
	<hr/>
	219,538 58
July 1, 1883, amount available	110,461 42

During the past season and until the middle of March Capt. J. B. Quinn, Corps of Engineers, was under my orders, and had general charge of the works above the Saint Joseph division, with headquarters at Omaha.

OPERATIONS FOR THE COMING SEASON.

These will necessarily be very limited, and will consist mainly in extending and keeping up the work already in place. The completion and protection of the large and costly plant is an imperative necessity, and will be a heavy draught on the balance of last year's appropriation. It is a grievous disappointment to all to be thus checked by lack of funds just as the organization had been completed and an adequate plant secured, and the results cannot but be serious so far as the future interests of this work are concerned. Unless the work can be carried on continuously with ample funds its success is very problematical.

As stated in my last report I regard \$1,000,000 at least as being annually required for its proper prosecution.

Money statement.

Amount received from sales of fuel to officers	\$97 86
Amount appropriated by act passed August 2, 1882	850,000 00
	<hr/>
	850,097 86
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$606,970 59
July 1, 1883, outstanding liabilities	92,927 19
	<hr/>
	699,897 78
July 1, 1883, amount available	150,200 08
	<hr/>
Amount (estimated) required for completion of existing project	7,150,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	1,000,000 00

AT SAINT CHARLES, MISSOURI.

REPORT OF MR. F. M. HARRIS, ASSISTANT ENGINEER.

SAINT CHARLES, MO., January 16, 1883.

MAJOR: I have the honor to submit the following report of the season's operations at Saint Charles, Mo.:

Notice was received September 17 that an allotment of \$22,000, including office expenses, was available for the prosecution of a *status quo* project for the Missouri River at Saint Charles, Mo.

Repairs on plant and all work necessary to the letting of contracts and the collection of material was begun at once. September 20 a contract for 30,900 feet of piling, to be delivered on the work, was let to John Cleary, of Chester, Ill., at 5 cents per foot. September 23 a contract for 1,000 yards of rock, to be delivered on the work, was let to James Short, of Saint Charles, at \$1.25 per yard.

I was notified early in the month that the Government launch Electra, at Glasgow, Mo., had been detailed to transport Grader No. 2 from Jefferson City, also a barge from Hermann, and to do the necessary towing for the season. She arrived the 26th of the month without her tow and laid up for repairs. After several unsuccessful attempts to run, she was tied up, and permission was obtained to charter the steamer Tuscumbia, of Jefferson City, which arrived with the fleet October 1.

Repairs were at once instituted on the Grader, and actual work begun in Saint Charles Bend by the middle of October. Meanwhile the project at the head of Saint Charles Slough had been completed. This consisted of a sill of closely woven brush 1,000 by 80 feet by 12 inches, weighted with bailed rock, connecting high-water banks, through which a double line of braced piles were sunk in the mid-stage section.

The following is the cost in detail:

COST PER LINEAR FOOT OF MATTRESS, 80 FEET WIDE, 12 INCHES THICK.

	Labor.	Material.
Grading	\$0.106	.....
Brush	0.510	\$0.010
Weaving	0.300	.....
Wire	0.075	0.020
Rock	0.100	0.120
Supervision	0.085	.....
	1.176	0.150 = \$1.326

COST PER LINEAR FOOT OF PILE-WORK.

	Labor.	Material.
Piles	\$0.500	\$0.400
Coal	0.100	0.090
Drift iron	0.060	0.070
Transportation	0.100	0.265
Supervision	0.120	.....
	0.880	0.825 = 1.705

1,600 feet mattress work, at \$1.326	\$1,326 00
284 feet pile work, at \$1.705	485 92½

Total cost of work at head of slough	1,811 92½
Deduct material on hand from last season	82 47½

Balance charged to allotment of September, 1882..... 1,729 45

The total cost exceeds the estimates about \$600, which represents the grading on the right bank and material not contemplated, the piles left over from last season being unserviceable.

The low stage of water made it necessary to carry the pile-work inland on either bank. For this purpose weighted frames were used. No netting was employed. The piles were sunk through the sill with but little difficulty, and it is thought a similar construction, modified to meet the exigencies of the case, will prove a valuable adjunct to present methods.

WORK IN SAINT CHARLES BEND.

Preparatory to weaving mattress, the bank was graded to a slope of 1 to 2½ feet. For this purpose hydraulic grader No. 2 was used. Extensive repairs were needed in order to obtain the best results, but owing to the lateness of the season only such were instituted as were absolutely necessary to the working of the machinery. These repairs are included in the summary under the head of "maintenance of plant." The actual

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working expenses amounted to 48.1 cents per linear foot of bank, or about 5½ cents per yard, and are as follows:

COST OF GRADING BANK PER LINEAR FOOT.

	Labor.	Material.
Fuel.....	\$0.016	\$0.112
Transportation.....	0.004	0.093
Labor.....	0.220	.....
Supervision.....	0.036	.....
	<hr/> 0.276	<hr/> 0.205=\$0.481
No. of linear feet of bank graded.....		2,700
No. of yards of earth moved.....		24,300
No. of yards of earth per linear foot of bank.....		9
Cost of grading 2,700 feet of bank, at \$0.481 per foot.....		\$1,298 70

REVTMENT.

In constructing a brush revetment, it was regarded as essential that the brush should be woven compactly into a perfect web, at least 8 inches thick and of sufficient width to reach the limit of scour; that it should not be depended upon perishable material, such as rope or wire for its strength; that such material is a source of weakness when used in the form of a netting as it is invariably depended upon for strength rather than the bond of the brush; that the mat should be well anchored to the bank and all rock used for sinking should be attached directly to the mat.

Shore-line probings show the formation in Saint Charles Bend to be identical with that previously reported for other portions of the reach, and an average width of 135 feet was fixed upon for the mat. A substantial beginning was made by turning a shoulder inland 100 feet, reaching practically to rock at the foot of the bluff. After repeated trials it was found impossible to weave a mattress of brush alone sufficiently strong to take the strains due to launching in swift water, and little progress was made until the direct attachment of rock was abandoned and the mattress strengthened longitudinally with wire rope.

Galvanized wire was extended laterally through the body of the mat and securely attached to buried rock at the top of the bank to guard against lateral movement incident to scour. Saddle-bag rock was thought to possess advantages over loose rock as weights. Arrangements were made to drop beaded rock with the tumbling beam, but were not completed.

All work was suspended on the 7th of December, on account of ice and snow, and orders were received to place the plant in safe harbor. Had it been possible to continue the work to its completion a fair financial showing could have been made; as it is, the cost of mattress and dike work is excessive.

It will be seen from the following distribution that the cost of brush delivered to the helper on the mattress-boat is nearly double that of all other items. This is attributable to a lack of suitable brush on the reach, to an inexperienced brush foreman, and to difficulties arising from subsistence.

COST PER LINEAR FOOT OF MATTRESS, 135 FEET BY 12 INCHES.

	Labor.	Material.
Brush.....	\$1.656	\$0.122
Weaving.....	0.690	.....
Wire.....	0.170	0.072
Rock.....	0.215	0.241
Towing.....	0.044	1.210
Supervision.....	0.106	.....
	<hr/> 2.881	<hr/> 1.645=\$4.526

1,160 feet, at \$4.526 per foot, \$5,250.16.

The project in Saint Charles Bend contemplated 4,300 feet of revetment, to be terminated with a series of five spur dikes. These dikes were located in a sharp gorge section, under a concave bank, and required more than ordinary strength to withstand the ice and drift. As repeated efforts failed to secure more than 16 feet penetration for the piles, a double line of A-bents was constructed. These were braced laterally and longitudinally, and faced with a spiral net of 36 square inch mesh made of galvanized wire.

The first two spurs, aggregating 1,000 feet, were completed, and have produced a marked effect in the bend. The remaining three were designed to be of lighter construction, excepting the exposed portions of the outer ends.

The total cost would have undoubtedly fallen within the estimate which was \$1 per linear foot. The following is the cost of that portion completed :

COST OF DIKE PER LINEAR FOOT.

	Labor	Material
Piles.....	\$0.600	\$0.500
Fuel.....	0.010	0.070
Drift-bolts.....	.....	0.020
Spiral net.....	0.016	0.340
Rock.....	0.100	0.040
Transportation.....	0.010	0.250
Supervision.....	0.120	.....
	1.000	1.220=\$2.22

1,000 feet, at \$2.22 per foot, \$2,220.

In conclusion, will say that an early allotment will be required to preserve the work placed this season, and a greater part of the material now on hand will be unavailable after the spring floods.

Very respectfully, your obedient servant,

F. M. HARRIS,
Assistant Engineer.

Maj. CHARLES R. SUTER,
Corps of Engineers, U. S. A.

IN VICINITY OF SAINT CHARLES, MISSOURI.

REPORT OF MR. S. WATERS FOX, ASSISTANT ENGINEER.

SAINT CHARLES, MO., June 30, 1883.

MAJOR: I have the honor to submit herewith a report of the operations under my charge, in this vicinity, during the fiscal year ending June 30, 1883.

A map of the reach from Downing's Point to the Saint Charles Bridge accompanies the report.

For an account of the operations at this point from July 1, 1882, to January 1, 1883, I would respectfully refer you to the season's report submitted January 18, by Assistant Engineer F. M. Harris, under whose charge they were conducted. Since then, no work was done until that hereinafter reported.

Notification was received March 10 that the available balance of the Glasgow allotment would be expended in the improvement of the river at Saint Charles.

A reconnaissance of the reach was made, and a project submitted March 12 for the construction of a revetment in Saint Charles Bend. Regard for efficiency and permanency, rather than the cost per linear foot, to govern the design.

The project was approved, and the preliminary work begun at once.

The Glasgow plant and that used in the improvement of the Gasconade River were brought here by United States tow-boat William Stone, and, together with the Saint Charles plant, overhauled and put into shape for service. Hydraulic grader No. 2 was sent to Saint Louis for repairs and alterations. The United States tug Electra, which was beached here by the ice in the break-up last season, was patched and launched, and sent to Bushburg in tow of steamer Stone. A contract for 8,000 cubic yards of riprap was let in open market at 75 cents per yard, delivered on barges.

Through the courtesy of the Wabash Railroad Company, in extending to us the use of their steamer Whitney until the arrival of the United States tow-boat Coal Bluff, we were enabled to begin weaving mattress April 5. Up to the date of suspension, May 25, 2,265 linear feet had been made. The United States tow-boat Coal Bluff, obtained from Major Mackenzie, United States Army, arrived here April 13, and was kept in active service until June 4, when she was sent to Saint Louis with instructions to report to you for further orders. A fleet of the new United States barges, built for the Missouri River Improvement, consisting of four large and four small ones, was delivered by United States tow-boat William Stone, May 6. The barges obtained from Major Ernst, United States Army, were relieved the day following and sent to Saint Louis in tow of steamer Stone.

MATTRESS WORK.

Of the revetment constructed in Saint Charles Bend last season by Assistant Engineer Harris, only the root and that portion of the upper work above the ice line was found to be serviceable. At one place, however (about 100 feet long), the grade had been washed away by the surface drainage. This portion of it was burned off and the bank regraded. The remaining 1,000 feet was utilized, the new brush being

1310 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

woven into it just above the ice line, and extending out 90 feet from the water line. Beyond the old work the bank was graded to a slope of 4 on 1, and the mattress woven to the top of the grade. The mattress was woven continuously of willow brush (maximum butt diameter, 2½ inches). The thickness was uniform, as nearly as could be, and about 16 inches. It was strengthened longitudinally and transversely by a system of three-eighths-inch wire cables, made of seven strands of No. 11 galvanized steel wire. Twelve of these were paid out, under tension, from reels housed under the brush platform on the lower side of the mat boat. Beginning at the outer edge, the first five cables were spaced 5 feet apart, the others 10 feet apart. In every feet of 10 feet a line of 3-inch toggles was twisted in the cables just back of the weavers.

The transverse cables were woven into the mat 10 feet apart; they were paid out from a reel on the outer end of the mat boat and laid along on the tops of the brush just behind the weavers; the shore ends were made fast to oak dead-men (6 inches diameter, 5 feet long) planted 4 feet in the ground, and 8 feet back of the top of the grade. The stream ends were made fast to the outer longitudinal.

The start was made in the following manner, viz:

A crib anchor, 4½ by 4½ by 5 feet, was laid 150 feet above the mat boat and about 100 feet out. Two parts of 1-inch cable led from the anchor to the stream end of the mat boat, and then along the upper gunwale to dead-men planted in shore. A fascine of willows was made about that portion of the 1-inch cable on the boat and around it; the longitudinal cables as well as the bridle lines running up-stream were made fast. The fascine also served as a selvage for starting the weaving.

HYDRAULIC GRADING.

As has been stated, the upper bank from the end of the old work was graded to a slope of 1 on 4.

Grader No. 2, with which the work was done, had been thoroughly repaired and provided with a cabin for quartering the crew. The old Worthington pump had been temporarily replaced by a Cope and Maxwell 16 — 10 × 24 inches. The grading was begun April 19 and continued, with but one interruption (April 23) caused by a broken piston rod, until April 27, when the Cope and Maxwell was taken off and a new Davidson pump 18 — 10½ × 18 inch put on. Work was resumed April 28, and continued until final suspension May 18, 1,530 feet having been graded.

The water was delivered from the boat through two sections of 4-inch rubber hose. The method of handling the stream was the same as that described in my previous reports.

The work done by each of the pumps is given in the following table, viz:

Pumps.	Discharge.	Material removed.	Water thrown to remove one cubic yard earth.	Cubic yards of material.
	<i>Ou. yds.</i>	<i>Ou. yds.</i>	<i>Ou. yds.</i>	<i>Per cu. yd.</i>
Cope & Maxwell.....	4,325	2,130	2.03	\$0 02.38
Davidson.....	13,996	18,292	0.77	0 01.06

Running expenses: One engineer, per month, \$90.00; one fireman, per month, \$45.00; one nozzleman, per hour, 20 cents; two hosemen, per hour, 17½ cents; coal per bushel, 13 cents.

ROCK WORK.

Of the 8,000 cubic yards of riprap contracted for, there has been delivered to date 4,650½ cubic yards. This was distributed on the mattress, as nearly as could be, as follows, viz: from the low-water line to mid stage, 2,500 pounds per linear foot; from low-water line to outer edge of mat, 1,200 pounds; from mid stage to top of bank, 400 pounds. The root and upper end of mattress, for about 50 feet, were loaded much heavier, the extra rock being supplied from a lot left on the bank from last season's work. It is proposed to place the remainder of the rock contracted for on the mattress after the river has fallen to about a mid stage. The cost of the revetment complete was \$6.75 per linear foot.

The property has been listed and is being transferred to the different points as directed. The location and extent of the work done and the recent changes in shore lines are shown on the accompanying map.

I am, Major, with great respect, your obedient servant,

S. WATERS FOX,
Assistant Engineer.

Maj. CHAS. R. SUTER,
Corps of Engineers. U. S. A.

AT NEBRASKA CITY, NEBRASKA.

REPORT OF MR. ARTHUR S. POTTER, ASSISTANT ENGINEER.

NEBRASKA CITY, NEBR., July 1, 1883.

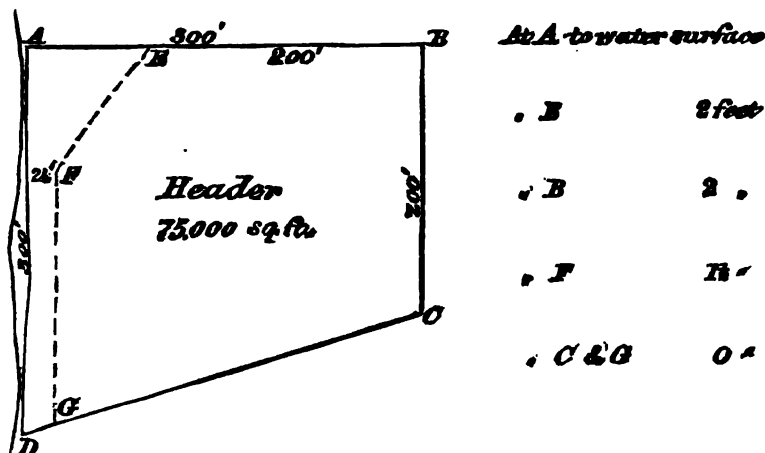
MAJOR: I have the honor to report the progress of work towards the ultimate improvement of Missouri River, at this point, for the fiscal year ending June 30, 1883.

Your instructions, dated September 7, 1882, were received September 9, informing us of the availability of \$32,182 for operations at Nebraska City, Nebr., and Eastport, Iowa. Accordingly, repairs to plant were made which consisted in rebotomping and decking four 12 by 50 foot barges, and side raking and altering the 80 by 16 foot barge, received with property from Plattsmouth, Nebr., for use in putting in mattress.

The revetment, ordered in instructions, to be placed in the bend above Eastport, was begun at a point 6,900 feet above the "point" or "landing," with a construction thought to be suitable and necessary to prevent, for a season, the channel from working behind it, called a

HEADER.

On September 25 grading for the header was begun. It covers an area of 7,500 square feet. Beginning at the point A (see sketch) it runs 300 feet on the shore line AB to B, at right angles to the shore at A, thence from B, 200 feet to C, thence to a point D, 300 feet from A, measured along shore. This area was excavated as



A contract was let for the excavation at 8 cents per cubic yard, but was afterwards settled for 3,372½ cubic yards at 8 cents, \$269.80. After the excavation was completed a mattress of willow brush was woven 12 inches thick over the whole surface; upon this was placed about 4 inches of earth, and over this another mattress woven 12 inches thick, into the texture of which two wire nets were incorporated as a basis of strength. Upon the last mattress rock were placed and attached to it, to the amount of 200 pounds to each 36 square feet of surface; then, over all, about 10 inches of earth, to prevent the brush from becoming brittle. To the nets and upper mattress of the header was securely attached the mattress extending 100 feet into the river at low water.

REVETMENT.

We have completed during the year, besides the header, 5,100 linear feet of revetment, consisting of a mattress of willow brush 150 wide and 12 inches thick, into the texture of which was incorporated a wire net. One hundred feet of the width of the mattress was in the water at a 4-foot stage, and 50 feet covered the bank, which was sloped 1 to 2½.

GRADING BANK.

Three hundred feet of bank was graded and included in cost for excavation of header; 1,523 feet was graded by contract, at 30 cents, and 675 feet by day labor, at 23½ cents per linear foot of bank. During the spring work 2,660 feet has been graded at a cost of only 19 cents per foot. The spring slope was to a higher stage of water, and therefore less material moved per foot.

BRUSH.

We have been particularly fortunate this year in being able to obtain a fine quality of brush, and a large portion of all that was used within 1 mile from the location of the header. The total expense at first for getting it to the location of the work did not exceed 20 cents per cord, and at last, when boating was necessary from the island, 75 cents, giving an average expense as follows:

6,875 cords, at .4352 + per cord = \$2,992.68.

ROCK.

Three contracts were let during the year for rock, the weight of individual pieces in no case to be less than 75 pounds or more than 200 pounds. The first contract covered the delivery of 256.46 tons at 50 cents per ton, niched ready for bailing. The contractor soon found that the price was too small, which brought into existence a second contract at 70 cents per ton, under which 718.58 tons were delivered. For spring work a third contract was let, covering not to exceed 800 tons, niched, bailed, and loaded. Under this arrangement 780 tons were delivered, at \$1.15 per ton.

Besides the rock received by contract, there has been used on the work about 1,000 tons—611 tons quarried during the year by day labor, and 389 tons previously on hand—making a total of 2,755 tons used, of which we have paid for 2,366 tons at \$1.2025 = \$2,845.21. The price per ton above includes every expense except transportation.

Rock on this reach is necessarily expensive, owing mainly to the heavy stripping, which is from 8 to 20 feet in depth, several feet of which is soapstone, and requires the continuous use of pick and mattock.

WIRE NETTING.

This work has been the subject of considerable experiment. The fact that the twist connection at the intersection of meshes was not all that could be desired has for some time been recognized. With this joint it is impossible to make square meshes and have the strands in continuous straight lines. With a view to a more satisfactory joint we have experimented on several intersections, as Figs. 1 to 9, Plate II, the most successful of which is that shown in Figure 9, "Weavers' knot." The application of this knot to the intersection of wires, was made by my assistant, Mr. Crow; its value was immediately recognized, but it was thought that the process of manufacture would be too slow and complicated to render it desirable. Experience, however, has shown its utility. The laborers themselves, although working slowly at first, became so expert in a short time as to make over their hands all the curves and loops necessary for the knots while moving from one intersection to the next, and this, too, with strands made of three No. 12 wires twisted together. A net made of single wire strands could be manufactured with greater ease and rapidity.

The elements of practical value of the "Weavers' Knot" are three, viz:

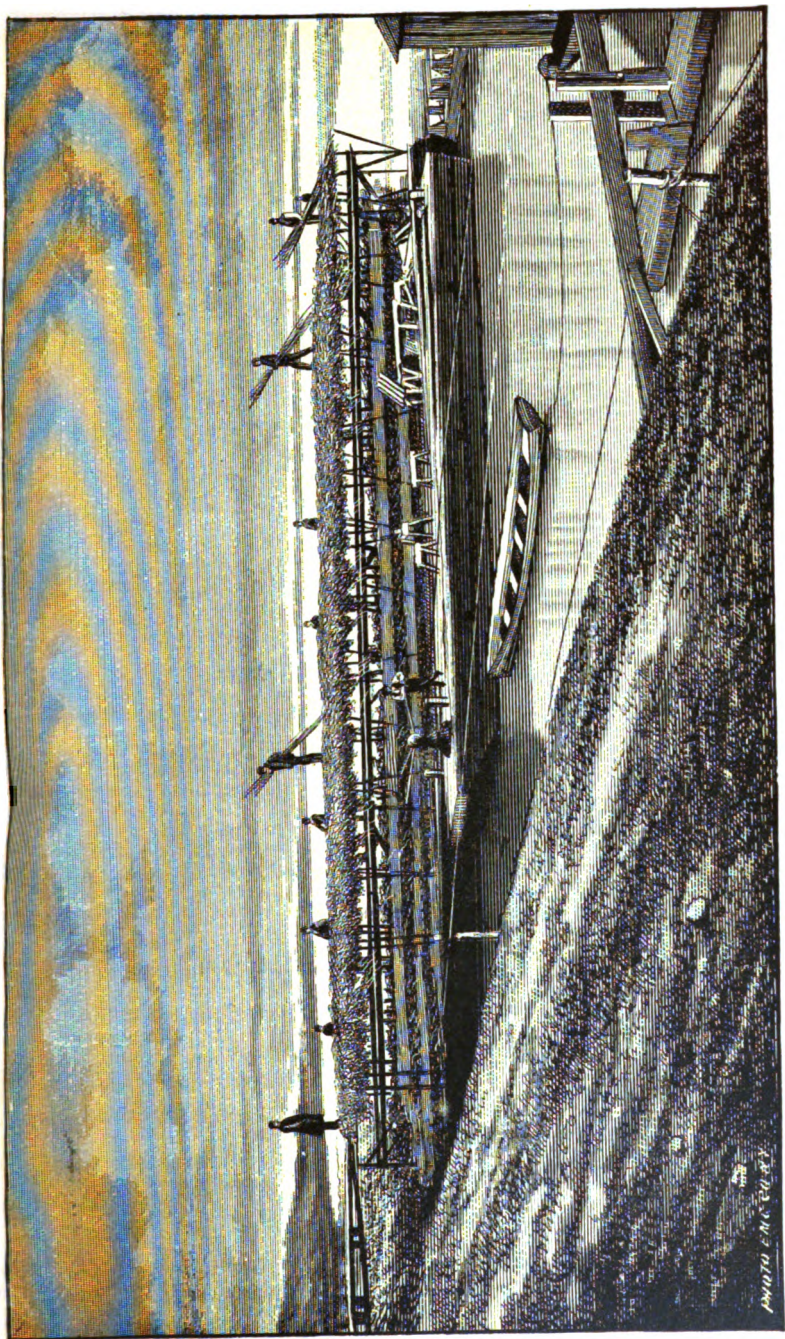
1. There is no possibility of slip, on whichever strand the strain may come.
2. It admits of square or rectangular meshes, each strand following the same straight line of direction.
3. If there are equal strains on each strand, experiment has shown that a break will occur no sooner or easier in the knot than elsewhere.

Galvanized wire should in all cases be used, as the difference in value of the wire is much more than made up by the rapidity of manufacture.

SURVEYS.

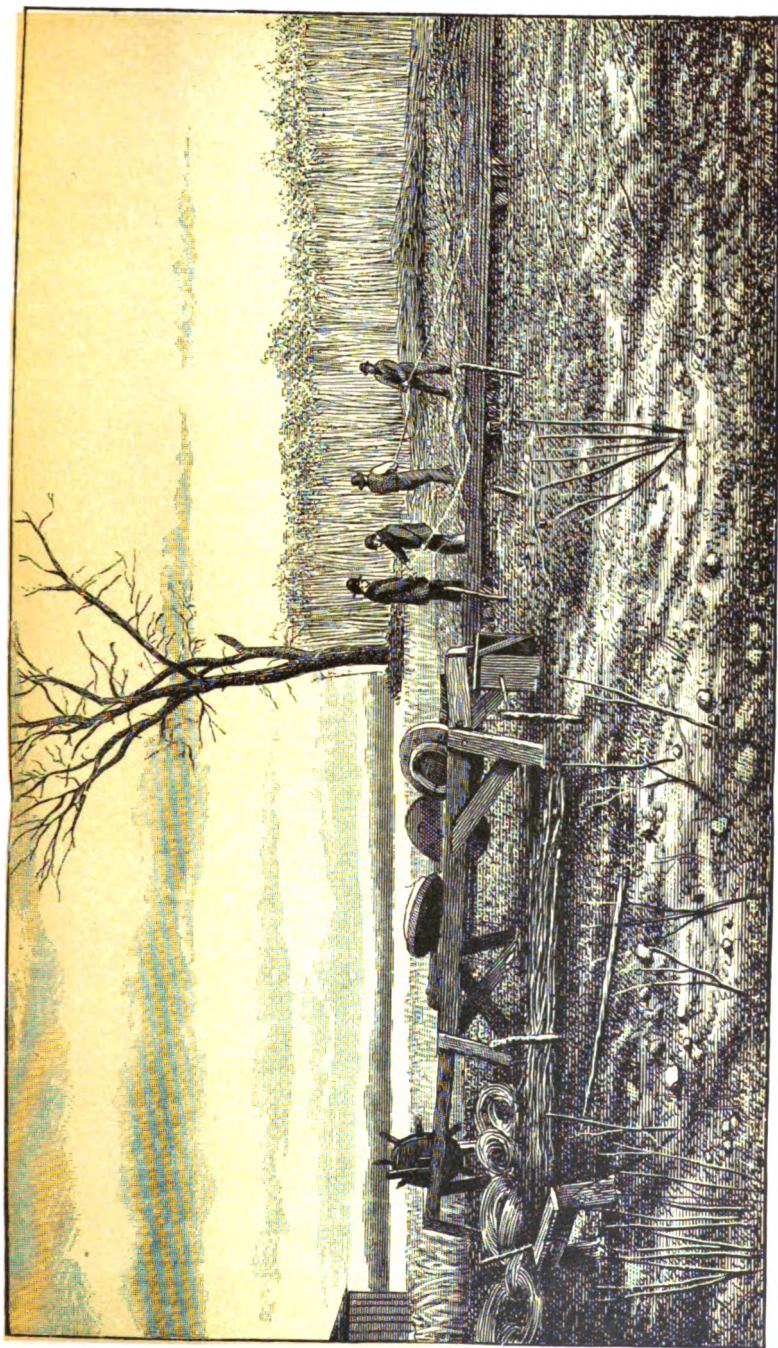
Beginning October 4, a low-water survey was made from the head of "Keg Creek Island" to the Missouri State line, covering all bars and changed shore lines; also, sections taken on established ranges, about each mile over the whole reach. This has been carefully platted to a scale of 1,000 feet per inch. At the beginning of this survey gauges were set at Pin Hook, Jones's Point, and Minersville, and each read continuously during the period of the survey. These readings, together with those of Wyoming and Nebraska City gauges for the same time, will give notes covering the

MISSOURI RIVER IMPROVEMENT, NEBRASKA CITY, NEBR.
Under direction of Major Chas. R. Suter, Corps of Engineers, U. S. A. A. S. Potter, Engineer in charge.



REAR VIEW OF MATTRESS BOAT.

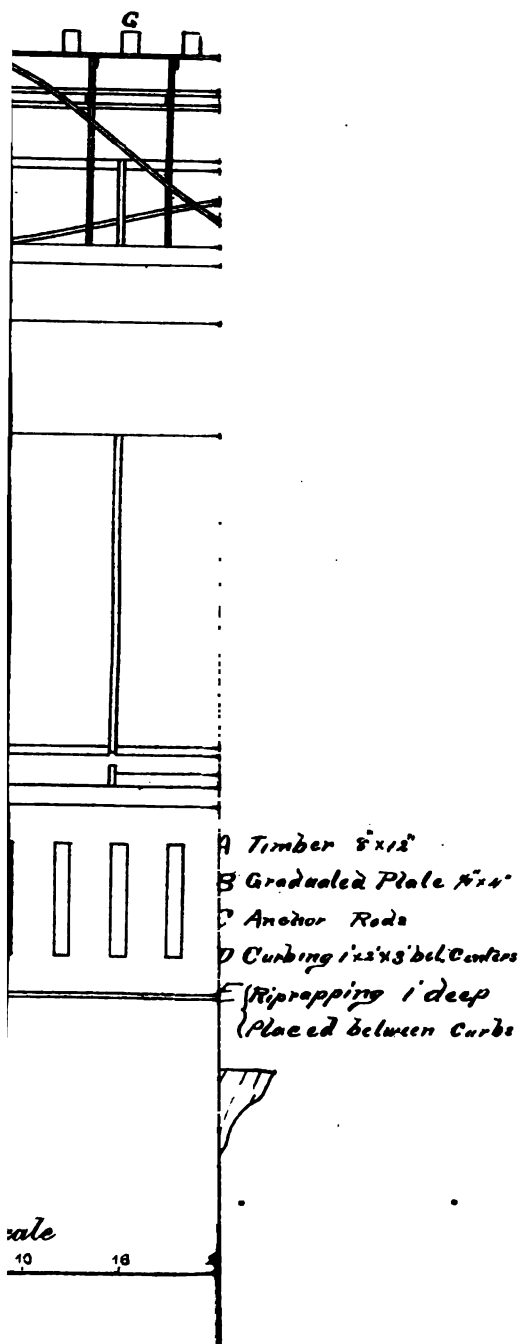
MISSOURI RIVER IMPROVEMENT, NEBRASKA CITY, NEBR.
Under direction of Major CHAS. R. SUTER, Corps of Engineers, U. S. A. A. S. POTTER, Engineer in charge.



WIRE NETTING TIED INTERSECTION.



Plate I



49
11-1
27
3
3-24-38
D. I. 49-76

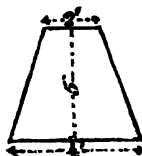
general daily slope over the reach. In addition to this, slope was taken with a floating level at each established range, from the head of the reach to about 1 mile below the mouth.

The water remained nearly constant during the survey, therefore the slope of the river days has been shown, and that given by the rod.

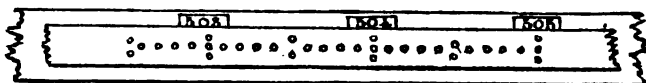
By reference to "sheet of slopes" it will be seen that the fall per mile gradually lessens as we leave the head of the reach, and varies from 1.3 feet to 1 foot per mile. This is undoubtedly due to the abnormal elevation of the river bed at the mouth of the Platte.

GAUGE.

A permanent gauge has been constructed at a point 100 feet above the old one established in 1878. The construction is as follows:



A rubble wall, laid in hydraulic cement, 53 feet long, was built on an incline of 25 degrees and with a section as shown. Upon this was placed an oak timber 8 x 12 inches attached to the wall by 27- $\frac{1}{4}$ by 4-inch anchor bolts. The timber was planed smooth and thoroughly painted. To the timber is secured an iron bar one-fourth by inches, graduated to feet and tenths as follows: Holes were drilled through the bar one-fourth inch in diameter and countersunk, in which were placed 1 $\frac{1}{4}$ inch brass screws, making a graduation as shown in the adjoining sketch. The bright surface



the screw-heads is very distinct when viewed against the iron back ground. The marks are indicated by stencils of brass plate one-sixteenth inch thick and one inch high, attached to the timber on the down-stream side of the iron. The bank on each side of the gauge is graded to the slope of the gauge for a considerable distance, and thoroughly riprapped for 10 feet on each side. See Plate I.

DORIS.

The steam launch Doris was used on this work during the year. She has required very few repairs. Some additions have been made, such as an outrigger on each side along the edge of the gunwale, 18 inches in width, extending from the front to the wheel-house. This was put on to facilitate the working of our method of attaching tow-barges to the launch. It is sufficiently illustrated on Plate I. We consider the arrangement very satisfactory.

GENERAL OBSERVATIONS.

It may be opportune to state certain observations concerning the present condition of the river and the work at this point.

Last year, on every crossing it seemed to be the tendency of the river to divide itself into numerous chutes, but this spring it is different. The many chutes have nearly consolidated into two main channels of nearly equal section.

In Pin Hook Bend there are two channels, one closely hugging the bluff down through Van Horn Bend and the other following the Iowa shore. These unite at Lewis Point and form a single channel for a mile or so; separate again and unite in the lower part of Civil Bend. A separation takes place again at Δ 349, one channel following the Iowa bank and the other the concave bank of Copeland's Bend. These channels met at one time opposite the head of Nebraska City slough; and, until the mouth of the eastern channel cut itself below the head, very extensive erosion took place in the slough, and fears were entertained that a cut off would occur and the water leave Eastport Bend for the shorter channel through the slough. All fear of such an event is passed for the present, however, as the action of the eastern channel is too far down on the island to affect the slough so as to produce an enlargement.

Up to the present date the revetment placed in Eastport Bend is perfectly intact notwithstanding the excessively high stage of water that has existed during the entire spring.

It is hoped that a larger amount of available funds than ever before will permit the continuation of the work further around the bend before sufficient changes occur above to unseat the present work. It is perfectly obvious that funds in large amount should be expended on this reach, and the training begin in the vicinity of the mouth of the Platte River and follow down stream, completing the rectification as you go. With this method the stability of that above will warrant the success of work below.

I desire to commend the valuable services rendered the work during the past year by my two assistants, Messrs. B. F. Crow and A. B. Ross, the former in charge of construction and the latter in charge of surveys and office work.

Very respectfully, your obedient servant,

ARTHUR S. POTTER,
Assistant Engineer.

Maj. CHAS. R. SUTER,
Corps of Engineers, U. S. A.

AT SIOUX CITY, IOWA.

REPORT OF MR. CHARLES F. POTTER, ASSISTANT ENGINEER.

ATCHISON, KANS., July 9, 1883.

MAJOR: I have the honor to make the following report upon the work of improving the Missouri River at Sioux City, Iowa, for the fiscal year ending June 30, 1883:

By your letter of instruction, dated September 4, 1882, I was placed in charge of the work.

During the month of September a survey was made of the reach between the Big Sioux and Floyd rivers. A second survey was made in December, at which time a new system of triangulation was established, previous high water having destroyed nearly all points of former surveys. In October a project for river improvement was submitted and approved, the necessary material collected, and the plant placed in condition for carrying on the work. The project contemplated a 1,000-foot extension to the dike on the right bank above the city, previously built by S. H. Yonge, assistant engineer, and also the construction of three cross-dikes of an aggregate length 1,050 feet.

The dike was commenced November 1, and consisted of two lines of piles sunk feet apart, with the same distance intervening between piles in the same row. Working was drift-bolted to both lines, and they were connected by horizontal and diagonal braces. The piling was larger than ordinarily used, the smaller diameters ranging from 9 to 14 inches, and lengths from 35 to 45 feet.

The depth of penetration attained varied from 20 to 26 feet, the average being 22 feet.

Pile-sinking was brought to a close November 24 by the heavy running ice.

Taking into consideration the low stage of water, the effect of the dike was unusually marked, first, by the rapid fill behind the dike, and, second, by the erosion on the shore-bar opposite. The fill was too rapid to permit the sinking of piles for cross-dikes, consequently that part of the project was abandoned.

Every arrangement was made for placing a foot-mat 30 feet wide outside the dike but the running ice prevented its construction.

During the winter the ice attained the unusual thickness of 3 feet, and trouble was anticipated at the breaking up of the river in consequence. The ice moved out March 14, however, without damage to the dike, but twenty-four hours later a gorge broke loose from some point above Sioux City and carried out the entire dike, or the portion not imbedded in the sand. Most of the piles were broken off, and had there been available money sufficient to rebuild they would have still done efficient service in way of preventing scour. Preparations were made during the winter in getting material for the continuation of the dike in the spring, but after the destruction of the portion already built the available money did not warrant further procedure.

In accordance with instructions received March 23, the Sioux City office has been closed and the plant transferred to Saint Joseph, Mo.

I take pleasure in acknowledging the efficient services rendered by Mr. J. C. McDith, who has had immediate charge of the work of construction during the past year.

I am, Major, very respectfully, your obedient servant,

CHARLES F. POTTER,
Assistant Engineer

Maj. CHARLES R. SUTER,
Corps of Engineers, U. S. A.

KANSAS CITY DIVISION.

REPORT OF MR. J. W. NIER, ASSISTANT ENGINEER.

KANSAS CITY, MO., April 30, 1883.

MAJOR: I have the honor of submitting the following report of operations on Kansas City division, Missouri River improvement, for that part of the present fiscal year ending April 30, 1883:

By your orders of September 11, 1882, that part of the general improvement of Missouri River, between the mouth of the Kansas River and Lexington, Mo., was placed under my charge.

An organization for the prosecution of the work was formed as follows: J. W. Nier, principal assistant engineer; B. V. Simpson, survey assistant; and J. D. St. C. Ellis, clerk.

The plant belonging to the old works at Kansas City and Lexington was given a general repairing with a view of organizing a working force, beginning operations and working to as great advantage as possible until a new plant could be prepared; subsequently the hydraulic grader was transferred to Samuel H. Yonge, assistant engineer in charge of Leavenworth division, leaving this division without any appliance of the kind. Orders having been received to resume work of a local character, the plant was moved to Lexington, and operations commenced above that place on the left bank on the site of former work put in, which had been damaged and required renewal.

The work consisted of a revetment 72 feet wide from the water's edge, with the left bank graded to a slope of 1 to 3, and a mattress placed thereon. The mattress was continuous from the top of the bank to the outer edge, with a total width of 137 feet. The total length of the low-water mattress was 4,217 feet, and 3,119 feet of bank protection. The bank was graded to a slope of 1 to 3, partially by means of a small pump on the pile-sinker and partially by hand. The cost of the work was nearly the same by both methods, the pump and boiler both being too small for work of that character. With apparatus of the kind, progress was of necessity slow, and bad weather stopped work before the work could be completed.

The low-water mattress was pushed through rapidly and was very satisfactory in every way. The methods of construction and appliances used were the same as were used by me heretofore. Greater strength was obtained by giving the mattress a thickness of about 7 inches instead of 2½ or 3 inches as was formerly the case. Galvanized wire, Nos. 8, 10, and 12, was used in the making of the net, the meshes of which were 32 by 40 inches. This net was thoroughly woven into the mattress from the water line to the outer edge.

At the junction of the mattresses made on the boat and bank was woven and sewed wire, while seams of wire were sewed through the mattress on the upper bank. Seams of wire ran from the low-water mattress to stakes driven on the top of the bank. A row of stakes was also driven at the low-water line; also through the mattress at such other points as necessity required. Rock (a hard variety of siliceous stone) was thrown on the mattress on the outer edge and below the low-water line. The mattress on the upper bank was also weighted with rock in sizes convenient for handling, no attempt having been made to break it into Macadam sizes, as no special results are derived by such a course. The limestone rock found along the river disintegrates so rapidly that the life of small pieces is very short. The benefits derived from breaking it into small fragments is, therefore, more fancied than real.

Bad weather effectually stopped construction work early in January by closing the river with heavy ice, leaving various portions of the floating property in very unfavorable places.

The preservation of plant involved considerable labor and expense. The pile-sinker was cut out and moved three-fourths of a mile through ice 1 foot thick into a place of safety. Such safeguards as could be taken for the protection of boats as would be to their safety on the breaking up of the ice were taken. Notwithstanding this, two small quarter-boats were smashed and sunk, badly damaged. The breaking of ice, due to a flood from the Kaw River, removed all obstructions from the river on this reach. Large, heavy snags were pulled out and carried away, leaving the river in the best condition for navigation known in many years. The impact of the ice on the revetment constructed at Lexington caused no injury whatever, except to destroy a portion of the bank which had been graded and not covered by mattress. Large fields of ice over 1 foot thick were forced upon the work until a hummock had formed 25 feet high above the top of the bank. The condition of the work after such a trial can be looked upon as evidence of its strength and durability.

Surveys made were as follows:

Triangulation over entire reach from Kaw River to Lexington.

Shore and bar lines over entire reach.

Cross-section at regular intervals over reach.

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4. Slope levels to cross-section. The slope was not determined, however, as river had become gorged with ice before the work could be completed.

5. Survey of Harlem and vicinity for Board of Division Engineers.

6. Topography between river and bluff from Kaw River to point opposite Miss City, on right bank.

7. Topography on left bank, from river to bluff, from Harlem to point 1 mile below Camden.

Topographical work was for the purpose of locating, with accuracy, all material used on river improvement; in short, to ascertain the resources of the division location of points for stations for a system of primary triangulation. This work in progress at the time of transferring my charge to Mr. Samuel H. Yonge, assistant engineer. The party was subsequently called in and disbanded, leaving this important work in an unfinished state. All notes and data bearing on this branch of work were transferred to my successor.

The available plant, resulting from the consolidation of the plant at Kansas City with that at Lexington, proved anything but efficient. All the barges were put out and given a general overhauling. Even with considerable labor and the expenditure of considerable money, the boats were ill adapted to the work. The launch Sabrina, with a small outlay, was put into good condition, and for a time proved serviceable. In December, when our work was under way, the engine frame of the port engine broke, disabling the boat for further service and placing our construction party in an embarrassed position.

During the fall a quarter-boat, 96 by 16 feet, with accommodations for forty men, was built, but not brought into service, owing to the impassable condition of the river in Fishing River Bend.

In compliance with your orders, the launch Sabrina was pulled out and her frames were changed. Sundry repairs to her hull and wood-work were also made the same time two small quarter-boats which were crushed by the ice were taken out and placed in serviceable condition. A pile-sinker, with small pump and boiler fitted for use as a grader, but proved wholly inefficient, the cost of work done by use being but little less than by hand labor. In short, the appliances in use were mostly badly worn and too limited in amount to carry along the work at the economical rate of speed.

By a change in the organization in February, Messrs. F. M. Harris and F. W. Simpson succeeded J. W. Pearl and B. V. Simpson. Construction work was resumed at Lexington in March, and was in progress at the time of transfer of my charge.

The consolidation of Kansas City and Leavenworth divisions, under the immediate charge of Samuel H. Yonge, having become necessary as a measure of retrenchment, by your orders of March 10, transferred my charge to Mr. Yonge on the 15th of March.

In conclusion, I wish to express my thanks to my assistants for valuable assistance rendered.

Respectfully submitted.

J. W. NIER,
Assistant Engineer

CHARLES R. SUTER,
Major of Engineers, U. S. A.

LEAVENWORTH DIVISION.

REPORT OF MR. SAMUEL H. YONGE, ASSISTANT ENGINEER.

KANSAS CITY, MO., July 9, 1882.

MAJOR: I have the honor to submit my report for the fiscal year ending July 1, 1883, as follows, viz:

By your letter dated September 11, 1882, the reach of the Missouri River between Atchison, Kansas, and the mouth of Kaw River, designated as "Leavenworth Division," was placed under my charge.

The point on Leavenworth Division at which works of improvement were most urgently needed was Kaw Bend.

After a personal inspection, a preliminary project for improving the river at this locality was submitted on September 28, 1882, and approved by you on September 30, 1882.

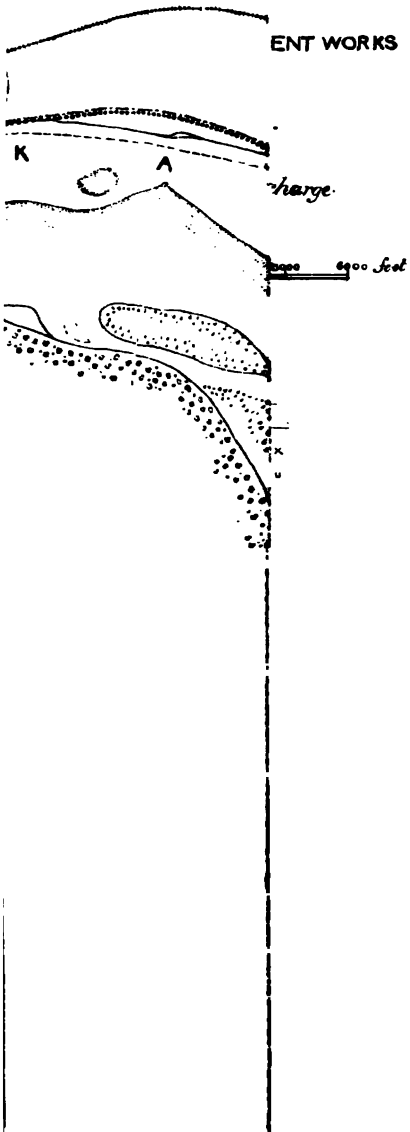
The immediate object of this improvement was to prevent the formation of a shoal through the narrow peninsula, between Kaw Bend and Harlem, by erosion of the left bank of Kaw Bend.

The danger of this cut-off is imminent, as the distance across this peninsula is only about 4,400 feet at the narrowest point, and the greater part of it is not covered by ordinary overflow. It was not contemplated, however, to construct works to prevent these overflows, for generally the advantages arising from such works would be only to a few, instead of being of a general benefit.

VER.

D.

ENT WORKS



The effects of a cut-off here would be as follows, viz :

1. To shorten the thalweg of the stream about 2 miles.
2. To deprive Kansas City of her harbor.
3. To sever the communication between this city and the north bank of the river by rendering the Kansas City bridge, now used by several of the most important railways, useless.

The encroachment of the river in Kaw Bend has been in progress for several years past. The causes which led to it appear to be the cutting away of the left bank in the lower portion of Parkville Bend, followed by a gradual shifting of the crossing at Quindaro down-stream, and a consequent erosion in Quindaro Bend, resulting in a shifting of the main axis of the stream in Kaw Bend; the changes in the shore-line of Parkville Bend producing corresponding changes in the position of the point of impact in each of the two bends below.

In the fall of 1879 about 4,400 linear feet of revetment and a weed dike, near the middle of the bend were constructed by Assistant Nier. Of this work there remained when I assumed charge, about 1,200 feet of revetment in 1881; about 3,000 feet of very light low-water mattress was constructed by Assistant Nier in the upper part of Quindaro Bend, of which work there is scarcely a trace left.

At the time of my examination of the river the portion of the bend where cutting was going on most rapidly was in the vicinity of two rock spur-dikes, which were then in course of construction by the Kansas City, Saint Joseph, and Council Bluffs Railroad Company, which dikes were never completed, their construction being discontinued as soon as the Government work was begun.

In the early part of October preparations for commencing work were made by collecting at Kaw Bend such plant as was available, and putting it in serviceable condition. This plant consisted of the steam-launch *Melusina*, a hydraulic grader, and five small barges, several of the latter being in poor condition, and all of the plant requiring repairs to a greater or less extent. One of the barges, 75 feet long by 12 feet wide, was fitted up with ways, and adapted to the purpose of constructing willow-mattress. (See sketch.)

As this plant was too limited to carry on work on even a small scale, two light-draught barges, 75 by 12 by 3 feet, were constructed.

As the point where work was to be conducted was isolated, and board and lodging or the employes could not be obtained within convenient distance of the works, quarters were erected and arrangements made for subsisting the force. Shed buildings, of cheap construction, were completed by October 21, 1882, and a force of men immediately put to work in procuring construction material, grading the bank, and removing snags and trees.

The general plan proposed for the protection works was as follows, viz :

The bank to be graded to a slope of $2\frac{1}{2}$ on 1; a woven brush mattress to be constructed, extending 75 to 80 feet into the stream from about low-water mark, and up the graded slope to the level of ordinary high water; the low-water port on to be weighted with rock ballast, and the upper bank mat to be covered with broken rock to a mid-stage elevation.

In view of the facts that a gang of men had to be trained to weave the mattress, and that operations were commenced late in the season, it was deemed best to confine the construction of mattress to the low-water portion, regardless of whether the bank was graded or not, as long as the river remained free of ice, and to grade as much of the bank to be protected as possible before the ground became frozen. This plan of procedure would not have been warranted under any other than the peculiar circumstances of the case, former experiences having shown that the best method of carrying on work of this kind is to grade the bank in advance of the mattress work, and to construct one unbroken mat from high-water mark out into the stream, the advantages gained by pursuing the latter method being that the tendency of the toe of the bank to slough away from wave action and that of the mat to slip from the bank are avoided.

To meet this latter contingency the shore-edge of the mat was anchored to sycamore posts 4 to 6 inches in diameter, which were set from 10 to 12 feet apart along the shore in advance of the mattress. These posts were sunk to a depth of from 6 to 8 feet by means of a water jet supplied by a hand-pump mounted on a scow. By means of the jet a pot-hole was made, into which the post was set. About twenty posts could be set in this manner in one hour by a crew of four men. Poles about 24 feet long and 4 to 6 inches in diameter were placed on the shore-side of the posts, and wired to them, forming a continuous waling.

The woven mattress constructed was very similar to that introduced at Sioux City, Iowa, during the spring of 1879, but differed from it in the following particulars, viz :

1. In being only about two-thirds as thick.
2. In wire net being used to facilitate weaving and to add to its strength.
3. In a continuous wire rope being used on the outer or stream edge of the low-water mattress.

4. In the use of posts spaced at regular intervals, to which the mattress was attached.

5. In the use of supplementary transverse wires connecting the cable with the posts and walings.

The wire net was made with a pin-twist, with meshes 16 by 16 inches, of No. 12 steel wire, annealed and galvanized. This net was made on a frame laid on the ground, in sections of 20 by 80 feet, which were rolled up, forming bundles about 16 inches in diameter, and laid on the mattress boat behind the launching ways. The several contiguous sections were joined together, both longitudinally and laterally, by a pin-twist, the outer section being attached to the cable, the inner one to the shore-walings. The netting being unrolled on the ways, a layer of large brush was passed in and out through its meshes transversely, and other brush woven into it.

The wire rope used in constructing the first 4,800 feet of mat was one half inch in diameter; in later constructions a five-eighth rope was used. The rope was paid out from a wooden drum, 3 feet in diameter, placed on a small barge behind the out-stream end of the mattress boat, the paying out of the cable being controlled by means of a wooden cam bolted on top of the outside needle of the mat boat.

In commencing a section of mat the end of the cable was carried up the bank and made fast to a tree or some other suitable anchorage.

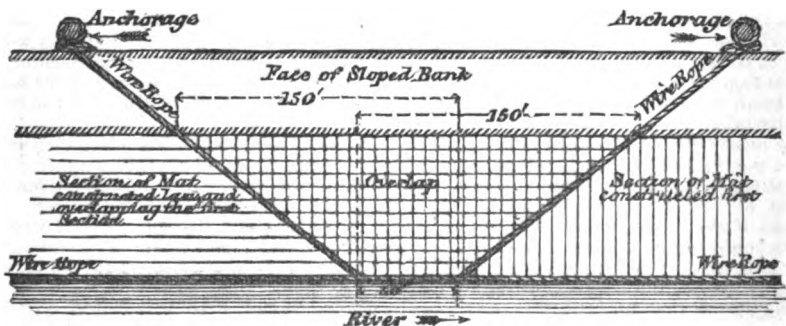
The transverse fastenings consisted of No. 18 by one-half inch flat steel wire, annealed and galvanized. Flat wire was preferred for this purpose because it was claimed by the manufacturers that a better quality of material was insured by the process of manufacture applied to this wire, and it was thought that with it a more secure hitch could be taken around the wire cable than with round wire.

The construction of low-water mattress was begun October 31, 1882. During the month of November, the weather being favorable, advantage was taken of every opportunity to push the work. No interference was suffered from floating ice until November 30, about which time the weather became intensely cold. On December 9 the river gorged above and below where work was being carried on, leaving an air-hole, in which the second section of low-water mat was completed and sunk. While several hundred feet of this mat lay afloat ice formed in its meshes, and in order to sink it it was first weighted with rock, after which holes were made through the ice, when it partially sank. The sinking was then completed by throwing on rock from a barge.

During the construction of the low-water mat it sometimes unavoidably happened that rock could not be had, when required for sinking the mat, in consequence of which as much as 1,000 linear feet of mat was sometimes floating on the surface. The effect of this was to cause a rapid deposit of soft material under the mat. The deposit accumulated, in places, to a depth of 10 feet. When the mat had been weighted with rock, it sank through this deposit. The effect of this floating mat was very marked in causing the sand-bar below, on the opposite side of the river, to cut away.

By December 16 two sections of low-water mat, 1,850 feet and 2,900 feet long respectively by about 8 feet wide, had been woven and sunk. From this it will appear that the low-water mat was not built in one continuous sheet longitudinally, although the practice of doing so is to be recommended on the score of economy when permissible.

The method of connecting two sections is shown in the following diagram:



On account of the urgency of the work, operations were continued throughout the winter. This proved to be very expensive as the men not only were less effective on

account of exposure to severe cold, but, also, at least 25 per cent. of the time was lost by stormy weather during which the force had to be subsisted, as in no other way would it have been possible to retain it.

During December, January, and February about 6,000 linear feet of upper bank mat was woven. The width of this mat varied from 30 to 60 feet. Its construction was similar to that of the low-water mat.

One effect of the ice gorges before mentioned was to cause the river to rise about 5 feet, which prevented a direct connection being made between the upper and lower mats in some places. In such cases, however, the upper bank mat was lapped over the low-water mat about 8 feet, and the overlap well weighted with rock. The upper bank mat was covered to a width of from 12 to 30 feet with rock broken into cubes from 1½ to 4 inches in size. One cubic yard of macadam was used to cover about 70 square feet of mat.

It has already been stated that about 1,200 feet of the revetment of 1879 remained. This was in a more or less imperfect condition. On account of the peculiar configuration of the river above this work, it was not exposed to the direct impact of the current. To prevent the bad effect of wave action, however, the portion of the upper bank work remaining was repaired, and advantage taken of the shape of the shore above the upper end of the work to construct a submerged dike, which was accomplished in the following manner, viz:

During the caving of the bank subsequent to the construction of this revetment, a large tree near its edge had fallen over on the mattress and formed the nucleus for a small wreck-heap. Commencing in the false bend about 150 feet above this point, a woven mat was begun, which was carried over and around the wreck-heap and thence 100 feet down-stream, to resist the action of eddies which would be produced by the obstruction at higher stages of water. This work was built on the ice and weighted with stone. When the river opened it dropped into position without damage. As the river rose this work became submerged, and had the effect of deflecting subcurrents, while the surface currents flowing over the obstruction prevented, in a measure, the formation of eddies below.

By an examination of the map showing progress of work at Kaw Bend, it will be seen that the shore-line has a number of jutting points, caused principally by the fact that the soil composing the bank has at different points different powers of resisting erosion. The effect of these jutting points was, before they were covered with mattress, identical with that produced by spur-dikes, differing therefrom only in degree.

Besides these natural irregularities, the Kansas City, Saint Joseph and Council Bluffs Railroad had, as stated before, commenced the construction of two spur-dikes. These dikes were inclined from shore up-stream. The eddy action produced by them was very severe, causing the bank to cut rapidly both above and below. Moreover, these dikes would sink from bottom scour nearly as rapidly as they were built up.

The low-water mat was carried around the natural points before described as well as around the dikes constructed by the railroad company, the effect of which in the latter case was to prevent a further settling of the dikes.

After all these projections had been trimmed down, the dikes to a slope of about 1 on 4 and the bank to about 1 on 2½, and the upper bank mat had been constructed, their effect was identical with that produced by spur-dikes in deflecting the current, but the action of eddies always attending such dikes was not experienced, as instead of erosions taking place in close proximity to these projections, accretions were formed.

It would appear from this experience that short spur-dikes formed of trees, felled across the upper bank mat, and combined with the revetment in the manner described, may prove valuable adjuncts in moving the thalweg of the stream away from the bank, especially in cases where the banks are composed of friable material, and circumstances demand extra precautions.

There were constructed to June 30, 1883, about 7,850 feet of low-water mattress and 7,610 feet of upper bank mattress, which, together with the repairs made to the revetment of 1879, involved the construction of about 975,000 square feet of mattress, the average thickness of which is about 8 inches. The average cost of weaving 100 square feet was about 27 cents; the average quantity of brush used by one weaver per diem, about 4½ cords; the average quantity of brush used per linear foot of mattress, about three-fourths of a cord. The average width of upper and lower bank mattress combined was about 115 feet.

As it was sometimes impossible to procure all the rock desired, on an average only about 670 pounds of rock per linear foot was used in sinking mattress. The weight of rock used to sink 100 square feet of mat was about 900 pounds.

When the ice gorges broke and the river opened in February, ice 16 inches thick was forced with great violence against the revetment, the effect of which was to lift the lower edge of the bank mat in a few places, where not attached to the low-water mat, without, however, causing any damage to the work.

During the late spring and summer floods, severe wind storms frequently produced

heavy waves, which rolled against the bank, and caused the face of the sloped bank to slough slightly, where the upper bank mat was not covered with rock. The mat, however, remained rigid, and the damage was repaired at slight expense. From this it became apparent that to maintain the even face of the slope it would be necessary to cover the upper bank mat entirely with broken rock. This measure was approved by your letter of May 23. The high stage of water since that date has prevented this work from being completed.

During the June rise all of the work in Kaw Bend was under water for about a week, but so far does not appear to have suffered any damage.

The total amount expended on the revetment at Kaw Bend amounts to.. \$34,063 15
The estimated cost of completing the work by constructing 240 feet of high-water mat and extending the covering of macadam to ordinary high-water mark is..... 8,154 97

Making total cost of 7,850 linear feet of revetment complete..... 42,218 12
or about \$5.37 per linear foot.

The hydraulic grader used to slope the banks at Kaw Bend had been used at Quindaro, Lexington, and Saint Joseph during the seasons of 1881 and 1882, and was undergoing repairs when transferred to my charge by Assistant Nier, which repairs were continued and completed on October 13.

The boat was provided with shears for snagging operations and two light derricks for carrying a 6-inch wrought-iron boom pipe to take the pump-discharge to the bank.

The old 6-inch hose on the grader burst on first trial, at a pump pressure of 80 pounds, and was replaced by a new 4-inch six-ply rubber hose.

The grading pump was a duplex Worthington, using steam expansively, with 10-inch and 16-inch steam cylinders, 10 $\frac{1}{2}$ -inch inside water cylinders, and 10-inch stroke. From continued pumping of gritty water the plungers and the linings of the water cylinders had become badly worn. To avoid the delay that would have been occasioned by procuring new linings, the water-cylinders were packed with a heavy sole-leather ring placed at the outer end of the cylinder lining, the inner diameter of the ring being made about one-half inch less than that of the linings. This expedient was found to answer all purposes, and the pump worked satisfactorily for several weeks. On November 9 the piston-rod on the side opposite to the suction broke near the plunger in the water-cylinder. This accident happened to the same rod several times afterward at intervals of about a week. The only explanation for this appeared to be that the suction had been taken on this side during previous work, and the cylinder lining had worn unequally.

The water supply was drawn directly from the river through a 7-inch wrought-iron pipe. The pump discharge was 6 inches. This was bushed at the pump to take the coupling of a 17 $\frac{1}{4}$ -foot section of 4-inch hose, connecting the pump with a 6-inch wrought-iron pipe 32 feet long, forming the derrick boom; 50 feet of 4-inch hose was attached to the end of this pipe, which with the play-pipe completed the water discharge connections. The play-pipe on the grader was made originally for the 6-inch hose, and as in the use of it the jet sprayed badly a new pipe for 4-inch hose was procured. The most satisfactory results were obtained with a 1 $\frac{1}{4}$ -inch nozzle, the stream from a larger nozzle being less effective on account of spraying.

Notwithstanding the repeated breaking of the piston-rod and other accidents, which caused delays, the grader did good service until she was laid up for the winter. Grading was commenced October 24. The total number of hours worked by the grader to December 9 was two hundred and fifty.

The grading was begun above the point where the mattress-work was commenced, and was carried along independently of the latter. It therefore happened that a long stretch of bank was graded and for some time left without any protection, for reasons already stated, and in consequence in some places sloughed out at the toe to such an extent that a considerable portion of it had to be trimmed by hand. For the same reason about 1,500 linear feet of bank was graded after the low-water mat had been constructed. This latter method, though objectionable on account of having to wash the excavated material over the shore edge of the mat, was preferable to the former one of leaving the toe of the bank unprotected.

The elevation of the bank of the river above low water in Kaw Bend varied from 14 to 23 feet. The slope given to the bank depended upon circumstances; in light material it was from 1 to 2 $\frac{1}{4}$ to 3, in tougher material from 1 to 2 to 2 $\frac{1}{4}$.

In the early part of December the weather became intensely cold, and the ground was frozen to a depth of 12 inches, which made grading very difficult; and as all of the bank which it was contemplated to revet during the season, with the exception of about 500 feet, had been graded, and, moreover, the piston-rod referred to above had broken again, grading was discontinued on December 9.

The lift of the pump was about 7 feet. The speed was usually about 68 strokes per minute for each plunger. Its rated capacity for this speed was 485 gallons. The

water pressure was kept at about 105 pounds. Assuming for the pump an efficiency of 80 per cent., the discharge should have been 388 gallons per minute. Allowing 20 per cent. for power lost by friction of moving parts, &c., it would appear that the work done by the pump was equivalent to twenty-nine horse-power.

A five-flue boiler, 25 feet long, was used to furnish steam for the pump. The diameter of the flues was 10 inches; the area of grate surface 22 square feet. This boiler furnished an abundance of steam at 110 pounds pressure.

In a steady run of 10 hours about 50 bushels of coal were consumed, including ash, clinker, and dust, the proportion of which to the combustible was not ascertained. This would show about 14 pounds of coal, including incombustible material, used per effective horse-power per hour.

The total quantity of coal used from October 24 to December 9 was about 2,000 bushels, which includes the quantity used in keeping the fire banked at night. The average quantity of earth excavated per bushel of coal was 47 cubic yards.

The total number of hours worked was two hundred and fifty; the length of bank graded 6,965 feet, or an average of 279 feet per day of ten hours.

The total quantity of earth excavated, as determined by actual measurement, was 94,000 cubic yards; the total quantity of water used, determined by calculation, 23,816 cubic yards; therefore one yard of water moved 3.26 yards of material.

The largest day's work was done on November 22, when 401 linear feet of bank, 20 feet high, consisting of light material, was graded to a slope of about 1 to 2. The total quantity of material excavated was about 5,940 cubic yards; the actual time worked by the pump about nine hours. This would indicate about 5.7 cubic yards of material excavated by one cubic yard of water.

The average cost of grading done with the pump to December 9, including wages and subsistence of crew, fuel, and other supplies, and superintendence, was 1.41 cents per cubic yard. The cost was increased by the fact that the crew was hired by the month, and was subsisted whether employed or not, and there was considerable time lost by delays caused by making repairs.

The grader was used only in the spring, but the pump was in very bad order, and as the piston-rod broke again, its use was discontinued and the remainder of the grading done by hand.

The face of the bank, as finished by the hydraulic grader, was usually very even and did not require trimming by hand, which was done only in cases where the toe of the slope had been washed away.

The greater part of the rock used on the work was furnished by the Kansas City, Saint Joseph and Council Bluffs Railroad Company at actual cost, and was delivered near the work by construction trains. The rock was transported from the railroad track by teams and barges.

The total quantity of rock delivered on the work up to June 30 was 2,830 cubic yards of about 3,000 pounds weight, the average cost of which per cubic yard, inclusive of all handling, was \$1.58. Of this, 2,172 yards were received from the railroad company, 306 by transfer at Kaw Bend, and 352 by transfer at Quindaro. This latter quantity was brought to Kaw Bend on barges by the steamer Melusina.

It proved a great convenience and advantage to be furnished rock by the railroad company, for if this had not been done, the work could not have been proceeded with, as none of the barges available had sufficient capacity or were suitable for transporting rock economically and safely.

There remains on the bank 432 yards of rock which has not been laid on the slope on account of the high stage of water.

There will be required to complete the covering of the upper bank mattresses constructed to date, about 4,000 cubic yards of rock.

The supply of brush in the immediate vicinity of the work being very limited, by far the greater portion of this class of construction material had to be procured from a distance, which, on account of the insufficiency of the means of transportation available, was attended with unusual difficulty and expense, it being necessary in all cases where brush was brought by rail, first to haul by wagon an average distance of 2½ miles from the brush patch to the railroad, and, after being transported by rail, again from the track to the work.

Nearly all the brush used was willow, with butt diameter of three-quarters to two inches, and from 10 to 20 feet long. As an exceptional case, a small quantity of dog-wood brush was used when the willow brush could not be procured.

There were procured—

From the vicinity of Kaw Bend, about 2,710 cords, transported from 1 to 3 miles by steamer Melusina and wagon.

From Waldron, Mo., 1,833 cords transported 12 miles by the Kansas City, Saint Joseph and Council Bluffs Railroad.

From Sngar Lake, Mo., 520 cords, transported 30 miles by the Kansas City, Saint Joseph and Council Bluffs Railroad.

1322 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

From Leavenworth Junction, Kans., 187 cords, transported 20 miles on barges by the steamer Melusina.

From Minaville, Mo., 1,595 cords, transported 10 miles by the Hannibal and Saint Joseph Railroad.

In all cases the brush was made up in bundles from 6 to 8 inches in diameter and tied with wire, a stock of old wire which had become rusty being used for this purpose.

The average cost of brush per cord including first cost on the stump, labor, subsistence, and transportation by railway, steamer Melusina, and wagon was \$1.61½.

A low-water survey of the river from Atchison, Kans., to the mouth of Kaw River was begun about the middle of October, but owing to the defective condition of the instruments at our disposal and our inability to secure for all of the positions in the survey party men trained for this particular class of work, little progress was made until about the first of November, when better instruments were furnished and the work progressed satisfactorily until about the middle of December, when the river gorged preventing further field operations. Early in the spring field work was resumed, the work done consisting in taking important topographical features and marking the most important triangulation stations with gas-pipe hubs set in cement.

The survey consisted in making a bank triangulation, meandering the shore-lines, sounding cross-sections and running slope levels.

In the triangulation system the triangles were, with few exceptions, well-conditioned. The smallest angle observed was 29 degrees 7 minutes. The limit of error was first fixed at 10 seconds, but as it was found that this could not be maintained with the instruments used without consuming too much time, it was increased to 20 seconds, which in no case was reached or exceeded.

To eliminate errors in plate graduation, the measurement of angles was usually repeated five times in both the direct and reverse position of the telescope.

The principal base was situated at Leavenworth, Kans. Bases of verification were located at Atchison and Wyandotte, Kans. The measurements of the bases were made either with a 50-foot steel tape or with 12-foot ash rods, tested by comparison with a United States standard steel bar, whose length was taken at 3 feet at a temperature of 60 degrees Fahrenheit. The rods were supported on trestles, which were adjustable, so that the former could be placed in a horizontal line.

The computed lengths of the bases at the ends of the reach agreed with the measured lengths within 0.27 and 0.34 foot, respectively. At each of the bases an observation was made for azimuth on the eastern elongation of λ Polaris.

There is submitted with this report a map reduced to half size from the original map constructed from data obtained in this survey. Where the bluffs were remote and could not be reached without extra work, their position was supplied from the maps of Assistant Wellman's survey. This was also done in the case of any topography at a considerable distance from the bank.

From a comparison of this map with that of Assistant Wellman's surveys made in 1878 and 1879 it appears that since these surveys were made about 2,200 acres of cultivated and timbered land has been washed away between Atchison and Wyandotte, Kans., a distance of about 55 miles, amounting to nearly 10 acres for each mile of river per annum. Assuming 18 feet, the estimated average height of bank above low water, together with the depth of water in the vicinity of the eroded banks, as determined by the cross-section work of the survey, as the total depth of erosion, the total quantity of soil washed away appears to be about 2,371,382,000 cubic feet, or an average of 10,000,000 cubic feet per mile per annum.

A further comparison of the maps shows several changes in progress, the most important being those at Cow Island, Rialto Bend above Leavenworth Bridge, and Kaw Bend, at all of which points cut-offs are threatening to take place, the one at Cow Island probably this year.

A table of areas of cross-section, &c., compiled from data collected on this survey, marked "Appendix A," accompanies this report.

By your letter of June 16, 1883, I was instructed to organize a party for the purpose of taking a series of discharge observations near Kansas City, above the mouth of the Big Blue River. This party was organized and entered upon its duties June 20, 1883.

The unusually heavy rains during the early part of June caused the tributaries of the Missouri River between Nebraska City and Kansas City to swell, in consequence of which an extremely high stage of water prevailed from June 17 to July 4, during which time all the bottom lands were flooded. On the morning of June 17 several crevasses occurred in the embankment of the Kansas City, Saint Joseph and Council Bluffs Railroad, between Kaw Bend and Harlem, a large volume of water thus finding an outlet across the neck into the river below Harlem. The total volume of water flowing across the neck was estimated to average not less than 25,000 cubic feet per second from June 17 to June 30.

The maximum annual gauge oscillation on the reach of river between Atchison, Kans., and Lexington, Mo., occurred at Kansas City, Mo., where it amounted to 22.8 feet.

By your letter of March 9, 1883, I was placed in charge of the Kansas City Division, and instructed to consolidate it with Leavenworth Division, with headquarters at Kansas City, Mo.

At this time the construction of revetment near Lexington, Mo., was in progress and a survey party was in the field, completing the survey of the reach from Kansas City to Lexington.

The status of the work at Lexington, Mo., at the time of the consolidation of the two divisions was as follows, viz:

About 3,300 linear feet of upper and lower bank mat in separate sections had been constructed, but only very little rock had been placed on the mat above an ordinary stage of water.

About 900 feet of low-water mat had also been constructed at the lower end of the work, but here the bank had not been graded.

The mattress used at Lexington was of a different construction from that employed at Kaw Bend, the meshes in the former being larger and but little strength being given to the work by the method of weaving the mat.

The low-water mat was not staked to the bank, but in places the shore-edge had been well weighted with rock.

As the hydraulic grader used at Lexington had not proved to be an efficient or an economical machine, and the stage of water was too high to grade the bank properly, work at this point was discontinued about the latter part of March, to be resumed as soon as the stage of water would be more favorable for working and a better grader would be available.

The operations of the Kansas City Division survey party were continued until April 14, by which time the triangulation stations had been marked with gas-pipe hubs set in cement and the survey of the reach completed with the exception of taking some interior topography of minor importance.

A reduced map of this survey will be forwarded within a week from the date of this report.

A table of areas, slopes, &c., constructed from the data taken in this survey marked Appendix B, accompanies this report.

Projects for completing the improvement of the river in the vicinity of Kaw Bend and Fort Leavenworth were submitted February 28, 1883, and approved by your letter of March 9, 1883.

It was contemplated in the first-named project to complete the protection works then in progress by retetting 13,000 linear feet of bank, involving among other work, the construction of about 1,500,000 square feet of mattress. Since then about 360,000 square feet of mattress, equivalent to about 3,000 linear feet of upper and lower bank mattress, have been woven, and about 55,000 square feet of upper work covered with macadam.

According to the supplementary project of May 23, to complete the works now nearly finished, there remains about 300,000 square feet of upper bank work to be macadamized. In addition to this there will be about 375,000 square feet of upper bank mat of the work yet to be constructed according to the project of February 28, to be macadamized.

In order to render that part of the work already constructed in the lower part of the bend and its proposed extension down-stream reasonably safe, it will be necessary to reconstruct what remains of the old revetment of 1879, for although this portion of the bank is at present not in any great danger, changes in the river above may, in the near future, expose it to the action of the current.

To complete the protection of Kaw Bend, therefore, the following work remains to be done, viz:

Completion of work already constructed by covering with macadam, per project of May 23, 1883, at an estimated cost of	\$7, 715
Ten thousand linear feet of the revetment proposed in project dated February 28, 1883, at an estimated cost of	38, 500
Covering with macadam 375,000 square feet of upper bank mat of this work as per supplementary project of May 23, 1883, at an estimated cost of	9, 632
Reconstructing 1,200 feet of the revetment of 1879, at \$5.10 per foot	6, 120
Total.....	61, 967

On the completion of the revetment at Kaw Bend it will be very desirable to establish a stable regimen for the river from Quindaro, Kans., to Kansas City, Mo. As a means to accomplish this end, it would appear advisable to construct works of correction in Parkville Bend, the effect of which would be to restore the shore-line in the lower part of this bend to the position occupied in 1878, and to move the crossing at Quindaro up-stream. It is believed that if this can be accomplished the main channel of the river will follow the left bank at Kaw Bend.

If something of this nature is not done, it is probable that the bank above the point

1324 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

to which it is now contemplated to carry the work will be exposed to the action of the current, which would necessitate a further extension of the revetment up-stream.

It was proposed in the project for Rialto Bend, now Fort Leavenworth, to train the river by a system of longitudinal and cross dikes, beginning at a point about a mile above the mouth of Bee Creek, these works to be extended down-stream as rapidly as results would justify or circumstances permit.

The objects expected to be thereby attained were to relieve the bank in Rialto Bend below Bee Creek from further erosion, thus preventing the formation of a cut-off, and to restore the crossing of the river to Fort Leavenworth.

As this work could not be proceeded with until the new plant was available, no operations have been carried on at this point.

Recent surveys show that considerable erosion has taken place in the upper part of the bend during the late floods, which may make it necessary to modify the project for this point.

In carrying out the work described in this report, I have been assisted in performing various duties by Assistant E. C. Shankland as principal assistant until April 16, 1883, when he resigned and this position was discontinued; Assistant R. H. Bacot, in charge of Kaw Bend subdivision; Assistant E. L. Cooley, in charge of surveys; Assistant E. F. Hermanns, in charge of reports, accounts, and other clerical work; Mr. D. W. Kinnard, in procuring construction material and in conducting special surveys and the collection of physical data.

Since the consolidation of the two divisions, Assistant F. W. Tuttle has had charge of the Kansas City division survey work.

All of these gentlemen have discharged their duties in a satisfactory manner.

Very respectfully, your obedient servant,

SAM'L H. YONGE,
Assistant Engineer.

Maj. CHAS. R. SUTER,
Corps of Engineers, U. S. A.

SAINT JOSEPH DIVISION.

REPORT OF MR. D. W. CHURCH, ASSISTANT ENGINEER.

ENGINEER OFFICE,
Saint Joseph, Mo., July 21, 1883.

MAJOR: I have the honor to submit the following report on the improvement of the Missouri River, Saint Joseph division, for the year ending June 30, 1883:

Previous to September 10 the only force employed was that necessary for the proper care of plant and the continuance of gauge readings.

In compliance with instructions creating the Saint Joseph division, an organization for resuming active operations was made about the middle of September.

The Saint Joseph division comprises 62 miles of river between Charleston and Atchison. Its topographical characteristics are shown on the accompanying map of the low-water survey of 1882, and its hydrographic features on the plats of "cross-sections and elements thereof," transmitted herewith.

Previous to the present year the work done in the portion of the river now comprising the Saint Joseph division was in the vicinities of Saint Joseph and Atchison, and has been fully discussed in the annual reports on work at those points.

The following-named works, carried on in accordance with approved projects, comprised the operations of the present year, viz:

Right-bank revetment above Elwood.

Dike work near Atchison.

Low-water and topographical survey of division.

These works will be discussed in the order named.

ELWOOD REVETMENT.

The destruction of the Bridge Company's Dikes, Nos. 2 and 3, during the flood of 1881, and the consequent destruction of a portion of the Elwood revetment of 1878, the absence of the dikes leaving a portion of the bank unprotected, has been mentioned in my reports on the Saint Joseph work for the years 1881 and 1882. The break extended from where Dike No. 2 was washed away to a point 4,100 feet below. The replacing of this revetment constituted what has been called the Elwood revetment work.

It consisted of a continuous brush mattress, woven in the usual manner into a wire-net backing, and having a width of from 80 to 90 feet below the low-water line, and

from 30 to 40 feet on the graded bank above. The thickness of the lower mattress was about 10 inches and that on the upper bank 8 inches. Stone, as large as could be conveniently handled, was placed on the portion below water and broken rock on the upper bank to a line two-thirds the way up the grade.

A drawing of the mattress-boat used accompanies this report.

The hull was 14 feet wide by 72 feet long, the ways projecting over either end sufficient to make up a total length of 80 feet. Extending lengthwise over half the width of the boat was an overhanging platform for carrying brush, and on the other half were the inclined ways upon which the mattress was made. The wire-netting was placed in rolls under the platform and passed onto the ways over rollers at their upper edge.

The wire net was made by the machine-twist method, which is described in my annual report for 1882. The mesh was diamond-shaped, 24 by 40 inches, with the longer diagonal running lengthwise the mattress. The net was strengthened longitudinally every 6 feet by an additional wire. No. 12 galvanized wire was used throughout.

The Atchison pile-boat was fitted up for use as a grader. The boiler was replaced by a tubular fire-box boiler of twenty-horse power. The pump originally on the boat was a Worthington outside plunger, steam cylinders 10 inches in diameter, water plungers 5½ inches in diameter, and stroke 10 inches. Another pump of the same dimension and make, transferred from Nebraska City, was placed on the boat, and the two used together through one hose. The discharge pipes of the pumps were at first connected by 2½-inch gas-pipe, from which the stream was taken to the bank through a hose of the same diameter, but this arrangement did not give satisfactory results. A 4-inch hose was then provided for carrying the water from the boat to the bank, and the two pumps were connected with it by 2½-inch hose and a V connection. The hose was carried to the bank by the derrick beam, from which it was suspended by straps. The stream was directed by means of a lever attached to the nozzle, and this arrangement, working on a universal joint, was supported by a small movable stand. The manner of using the stream was about the same as on the Bonton Revetment in 1881, it being directed against the bank from a point about half way up the grade. The size of the nozzle which gave the best results was 1½ inches. The bank was graded to a slope of 2½ on 1, and a 3-foot breast was left at the top to be thrown over the high-water protection after the completion of the latter. The grading was mainly done ahead of the mattress-boat.

For 2,630 feet, measuring from the upper end, the high-water protection was made after the under-water work had been completed; but on the remainder, the two were carried along together. The wire-net backing was dispensed with on the upper bank work, except for a narrow width along the foot of the grade.

The revetment work was stopped December 2 by running ice. It was, however, continued during the winter, whenever the weather would permit, in order to leave as little unprotected bank as possible at the time the ice would run out in the spring. The work was completed May 5.

The brush used was willow, cut from the south side of the Elwood bottom and delivered by teams; 0.47 cords, per linear foot, was used in the portion of mattress under water, and 0.28 cords on the upper bank.

A portion of the rock was taken from the points of the old dikes which were exposed at low water, and the remainder was purchased in the quarry at Wathens and delivered by teams. The amount used, per linear foot, was 677 pounds for the under-water work and 450 pounds on the upper bank. The cost of the revetment was \$2.98 per linear foot.

Three views were taken showing the method of construction, and are transmitted herewith.

ATCHISON DIKE WORK.

The objects to be accomplished by the Atchison work were the rectification of the channel above the bridge so as to bring it under the draw-span at right angles and the closing of the chute behind Atchison Island.

The project for channel rectification contemplated the construction of a main-line dike 4,000 feet long, about on the line of the dikes constructed in 1882 by Assistant G. T. Nelles, and such cross-dikes as were found to be necessary to reinforce the main line and build out the left bank.

On account of delay in the arrival of pile-boats and other plant transferred from Sioux City and Omaha, the extraordinary stage of the river during the time that the work was being done, and changes in its condition previous to commencing, it was found impossible to prosecute the work in the manner proposed.

The Sioux City plant, including one pile-boat, together with the Omaha pile-boat, arrived May 12, and the repairs and alterations necessary before beginning dike work were at once commenced.

For convenience the pile-boats were numbered as follows, viz: The Saint Joseph

boat, previously used as a grader, No. 1; the Sioux City boat, No. 2; and the Omaha boat, No. 3.

The length of No. 1, as used for grading, was increased by joining with it another boat in such a manner as to practically make one continuous hull 96 feet long. The second boat carried the derrick and a pile platform 16 feet high. The method of handling the pile and the application of the jet was that generally adopted along the river last season. Nos. 2 and 3 have already been described in connection with the works at Sioux City and Omaha in 1882. The machinery and derricks on both these boats were set up after arriving at Saint Joseph, and on No. 2 there was placed an additional upright boiler similar to the one already on the boat.

In addition to the above preparations quarter boats were provided for the accommodation of the construction force.

On May 23 pile sinking was commenced on the main line dike as at first laid down in the project. Two lines of piles were sunk, 10 feet apart, with piles the same distance apart in the row. Longitudinal and transverse waling was put on with five-eighth-inch drift bolts. It was the intention to add a third line of piles and protect the dike against scour with a mattress-sill and foot-mats had not the extension of the first two rows been found impossible.

The river rose rapidly from the time of beginning the work and soon reached the stage of ordinary high water, producing a rapid cutting in the pocket a short distance above the dike. The fourth day after starting, the boats were sinking piles in 20 feet of water. The current was so strong that it was almost impossible to accomplish anything, and there was little prospect that the dike could be maintained, even if it were possible to continue it. This part of the project was therefore abandoned.

The river was then so high that there was no point within proper limits where a new main dike could be started without reaching water too deep for pile-sinking in a very short time, and it was therefore decided to proceed with the construction of cross-dikes until the river should reach a lower stage.

Cross-dikes B, A, and C, shown on the map, were constructed in the order named, each being extended as far as the depth of water and current would permit. Dikes A and B consisted of three rows of piles, 12 feet apart each way, braced longitudinally and transversely the same as in the main line dike above described.

A wire net, 40 feet wide and having a mesh of 1 square foot area, was hung on the upper side of each of these dikes. Dike C consisted of a single row of piles, with longitudinal waling and wire net. Cross-dikes A and B were run nearly at right angles to the current, and could not be extended beyond a distance of about 600 feet from shore, as the current then became so strong as to make it impossible to move the pile-boats along the dikes. Slant-dikes were then started from each of these dikes, from points about 300 feet from shore, with the intention of extending them out to the proposed main line. The outer ends of the cross-dikes were, however, scoured off, and the water soon became so deep that the slants could not be extended.

A rapid fill took place after the screen was put on these dikes, and the channel was shifted nearly to the point desired. There was an accumulation of drift against dike A, which eventually carried it out, and the loss of the work below was threatened unless the stream could be diverted at the upper end. The dike shown on the map as "Training-dike" was then started from the shore-bar formed by the work of 1882.

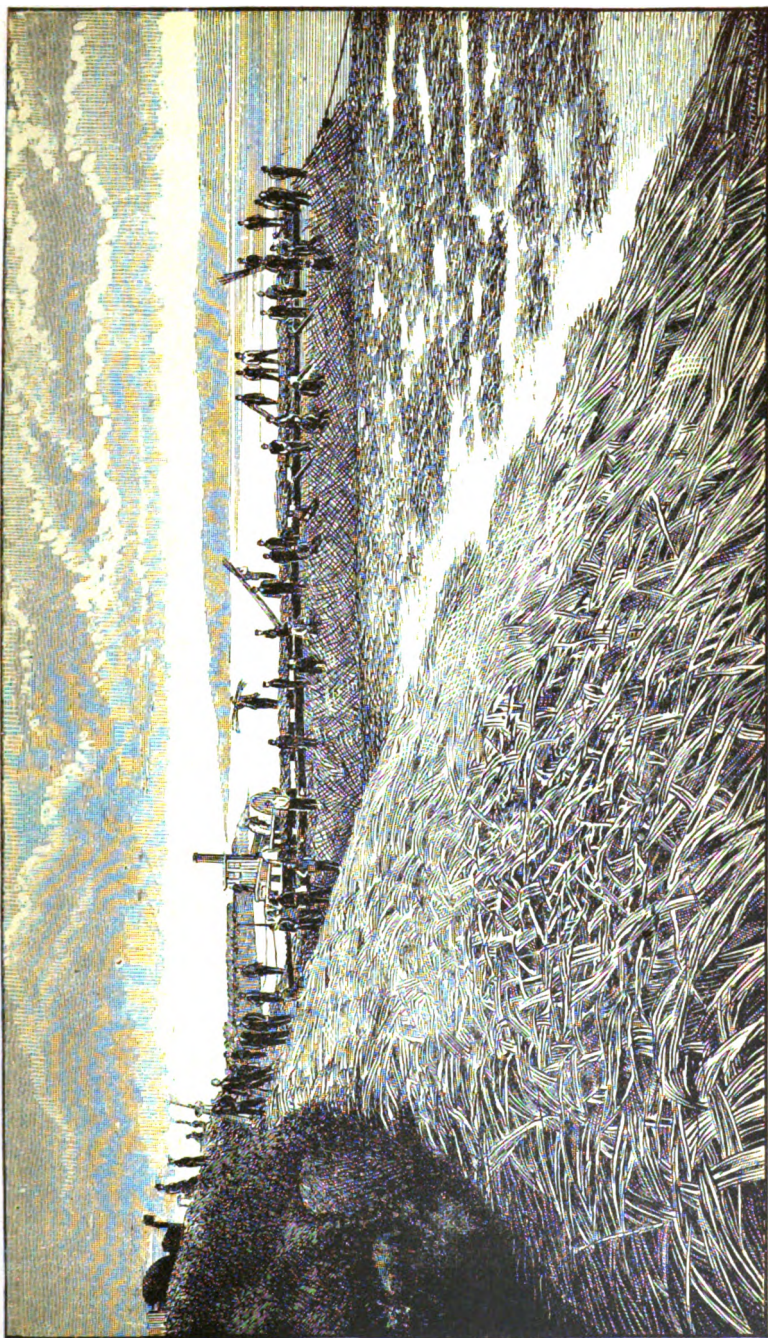
As far as completed this dike was in every way the same as the main line dike at first proposed, with three rows of piles, mattress-sill, 45 feet wide, and foot-mat.

Between June 16 and 19 the river rose 4 feet very suddenly on account of local rains. The shore bar, from which the training-dike was started, was covered, and a rapid scour set in, carrying out about 150 feet of the dike at its upper end, and forming a deep channel along shore, which threatened to destroy the work below. The small portion of the main line dike constructed at beginning work and that remaining of the dike of 1882 were carried out by this rise. The three pile-boats were at once set at work to connect the training dike with the high bank. The shore channel was not fully closed until Training-dike B, and a new Cross-dike A, had been constructed. The latter dikes were similar in every respect to the original Cross-dike A.

Operations at Atchison were suspended June 30. As a result of the work, a high bar was formed from the head of the training-dike to a considerable distance below Dike C, and extending to the outer ends of the cross-dikes. It is impossible to tell, at the present stage of the river, how far out this bar will extend at low water, but in any event the training-dike should be extended another season, and the shore bar carried out to that line at as near its present height as possible.

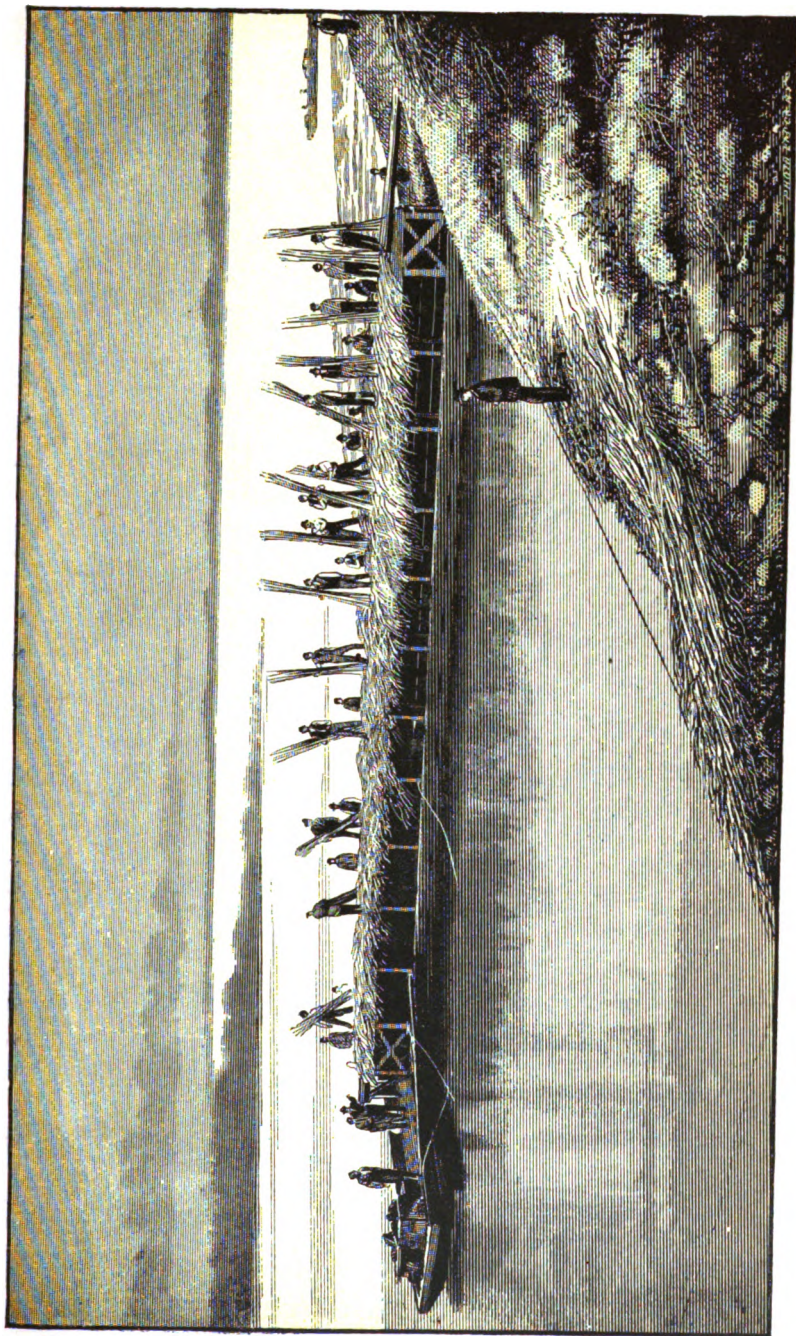
The plan for closing the chute was to repair the dikes constructed in 1882 where possible, and to add a sufficient number at convenient intervals to take up the total fall of the chute without allowing enough to accumulate at any one dike to destroy it, the dike at the head to be strong enough to keep out the drift, and the others to be of lighter construction. It was the intention to use tripods in this work, but, as high water came on several weeks earlier than usual, their construction was impossible with the plant available. The emergencies constantly arising at the work on

REMOVING THE IRON PILING. S. J. JONES, DIVISION.
Under the direction of Major CHAS. R. SUTER, Corps of Engineers, U. S. Army. D. W. CHURCH, Assistant Engineer in charge.



ELWOOD REVETMENT.
VIEW SHOWING MATTRESS READY FOR SINKING.

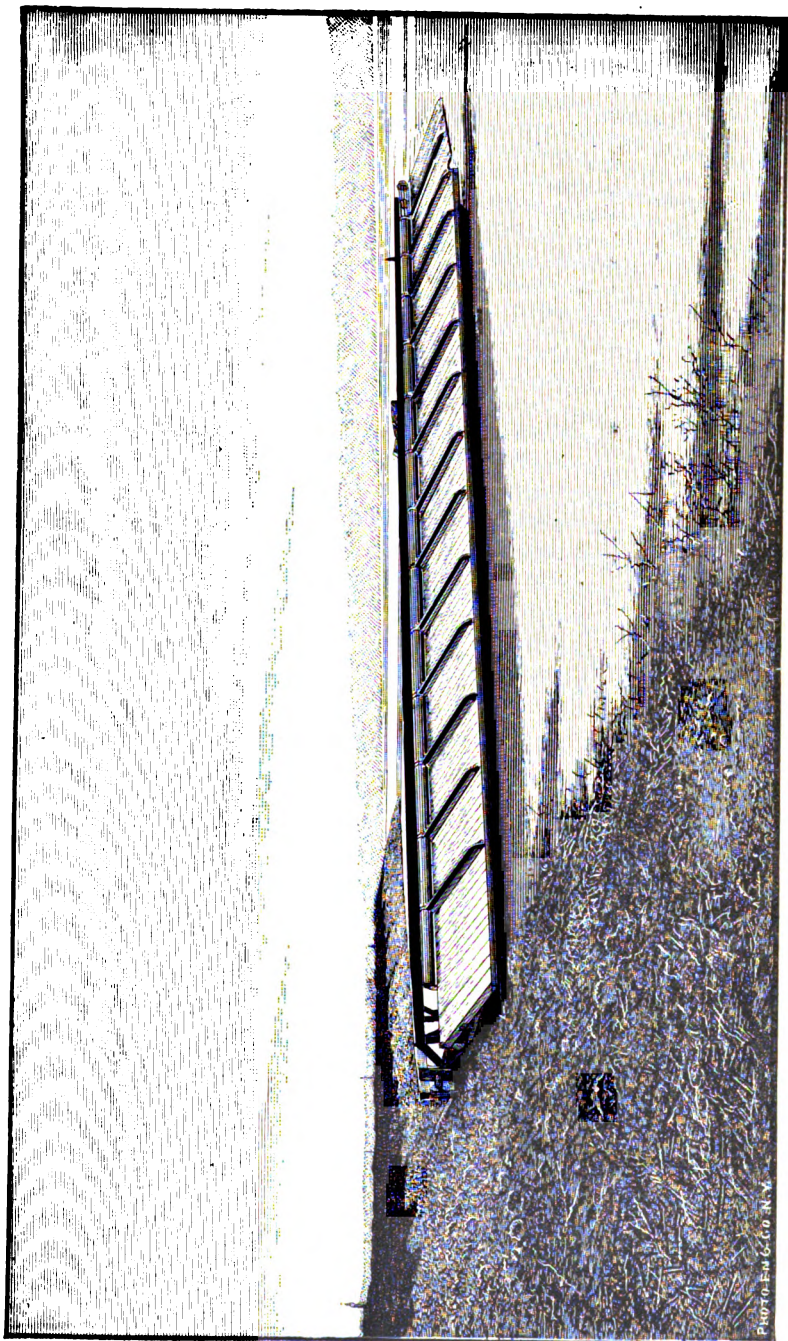
MISSOURI RIVER IMPROVEMENT, ST. JOSEPH DIVISION.
Under the direction of Major Chas. R. Suter, Corps of Engineers, U. S. Army. D. W. Church, Assistant Engineer in charge.



ELWOOD REVETMENT.

VIEW OF MATTRESS BOAT LOOKING UP STREAM.

MISSOURI RIVER IMPROVEMENT, ST. JOSEPH DIVISION.
Under the direction of Major CHAS. R. SUTER, Corps of Engineers, U. S. Army. D. W. CHURCH, Assistant Engineer in charge.



ELWOOD REVETMENT.

VIEW SHOWING COMPLETED WORK AND MATTRESS BOAT USED IN CONSTRUCTION.



the Missouri side made it impossible to spare the pile-boat for use in the chute, and consequently only one dike was constructed.

This was located near the lower end of the chute, as shown on the map. The piles were driven every 10 feet in two rows 15 feet apart, and were protected by a heavy mattress-sill. Notwithstanding the fact that the dike was broken through near the middle and about 100 feet carried out, the effect has been to materially reduce the cross-section of the chute and raise its bed.

SURVEYS.

The general survey of the division and discharge observations taken at Atchison comprise the principal survey work of the year.

The survey of the division consists in establishing a system of triangulation, running out-shore and bar lines, sounding cross-sections every half mile, establishing level benches and taking slope at each cross-section, and in locating the bluff lines and all interior topography. The slope was taken in two days with the floating slope-rod described in my annual report for 1881. By this means the elevation of the water-surface was taken in the channel instead of at shore.

The shore line and hydrographic work was done at low water between October 7 and November 24, and the interior work between the latter date and April 21.

Such triangulation points as were in a permanent location were then replaced by gas-pipe hubs, and permanent cross-sections were established every half mile. The work done in making the above survey was as follows, viz:

Triangulation points established.....	135
Stadia line run..... miles..	370
Levels run..... miles..	94
Cross-sections sounded.....	127
Level benches established.....	233
Triangulation points made permanent.....	39
Permanent cross-sections established.....	117

Fifty-three discharge observations were made at Atchison after July 1, 1882, completing a series of sixty-seven taken between June 7 and November 29.

A tabulation of these observations, together with a map showing location of ranges and plats of individual discharges, accompany this report. Double floats were run over three ranges 250 feet apart, and soundings were made after each float.

The sections were also sounded each day before running floats. The telegraph was used in signaling.

In computing the discharges the middle cross-section and transverse velocity curves were plotted, and by taking the product of velocity and depth at each 50 feet of width the transverse curve of discharge was determined.

The discharge was then measured from this curve by the planimeter. The datum areas in the tables were measured below the elevation of the highest water, 691.6 feet on the gauge, which occurred July 3. The zero of the gauge used is 322.656 feet below the Saint Louis directrix.

The accompanying curve of variation of discharge with gauge was worked up by Mr. James A. Siddon, of your office.

The office work of the survey party was as follows, viz:

Platting general survey of division.

Computing sixty-seven discharges taken at Atchison.

Computing five discharges taken at Saint Joseph in 1878.

Reducing and platting notes of one hundred and fifty-one cross-sections sounded in the vicinity of Saint Joseph between 1875 and June 30, 1882.

Reducing and platting notes of one hundred and five cross-sections sounded on Saint Joseph division in 1882.

Recording and platting gauge readings.

The following maps and drawings are transmitted herewith, viz:

Tracing of map of Saint Joseph division, low-water survey of 1882-'83.

Map showing location and extent of improvement works in the vicinity of Saint Joseph.

Map showing location and extent of improvement works in the vicinity of Atchison, Kans.

One sheet of cross-sections referring to dike work at Atchison.

Tabulation of discharge observations made at Atchison in 1882, with map showing location of sections and discharge curves—4 sheets. Plats of individual discharges taken at Atchison—55 sheets.

Tabulation of discharge observations made at Saint Joseph in 1878, with plats of individual discharges—2 sheets.

Plats of one hundred and fifty-one cross-sections taken in the vicinity of Saint Joseph between the years 1875 and 1882, and one hundred and five taken on Saint

1328 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Joseph division in 1882, together with maps showing their location and tabular area, &c.—48 sheets.

Sketch of slope-float.

Sketch of mattress-boat used in 1882-'83.

One dozen copies each of three views showing Elwood revetment work.

The works carried on during the year were under the immediate charge of the following-named assistant engineers:

The Elwood revetment, under Mr. T. C. Bradley; Atchison dike work, under C. F. Potter, and surveys previous to February 1, under Mr. W. H. McKney later under Mr. B. V. Simpson.

I have the honor to be, major, very respectfully, your obedient servant,

D. W. CHURCH,
Assistant Engineer.

Maj. CHARLES R. SUTER,
Corps of Engineers, U. S. A.

U 4.

IMPROVEMENT OF MISSOURI RIVER AT SAINT CHARLES, MISSOURI.

No special appropriation was made for the continuance of this work but an allotment from the general appropriation having been authorized operations have been in progress, which will be described under the head of "Improving Missouri River from its mouth to Sioux City."

Money statement.

July 1, 1882, amount available.....	\$49
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	49

U 5.

IMPROVEMENT OF MISSOURI RIVER AT CEDAR CITY, MISSOURI.

No appropriation having been made for this locality, and the necessity for further work not being urgent, the plant was transferred to Saint Charles, and all operations suspended.

Money statement.

July 1, 1882, amount available.....	\$310
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	310

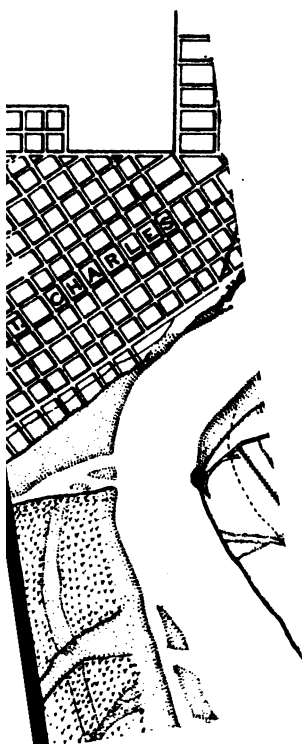
U 6.

IMPROVEMENT OF MISSOURI RIVER AT GLASGOW, MISSOURI.

No special appropriation was made for the continuance of this work but an allotment from the general appropriation having been authorized operations have been in progress, which will be described under the head of "Improving Missouri River from its mouth to Sioux City."

Money statement.

July 1, 1882, amount available.....	\$204
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	204



U 7.

IMPROVEMENT OF MISSOURI RIVER AT LEXINGTON, MISSOURI.

No special appropriation was made for this work, which was, however, embraced in the general project, and will be described under the head of "Improving Missouri River from its mouth to Sioux City."

Money statement.

July 1, 1882, amount available	\$71 36
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	71 36

U 8.

IMPROVEMENT OF MISSOURI RIVER AT KANSAS CITY, MISSOURI.

No special appropriation was made for this work, which was, however, embraced in the general project, and will be described under the head of "Improving Missouri River from its mouth to Sioux City."

Money statement.

July 1, 1882, amount available	\$51 27
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	51 27

U 9.

IMPROVEMENT OF MISSOURI RIVER AT FORT LEAVENWORTH, KANSAS.

No special appropriation was made for this work, which was, however, embraced in the general project, and will be described under the head of "Improving Missouri River from its mouth to Sioux City."

Money statement.

July 1, 1882, amount available	\$39 06
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	39 06

U 10.

IMPROVEMENT OF MISSOURI RIVER AT ATCHISON, KANSAS.

No special appropriation was made for this work, which was, however, embraced in the general project, and will be described under the head of "Improving Missouri River from its mouth to Sioux City."

Money statement.

July 1, 1882, amount available	\$4,157 14
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	4,187 14

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U 11.

IMPROVEMENT OF MISSOURI RIVER AT SAINT JOSEPH, MISSOURI

No special appropriation was made for this work, which was, however, embraced in the general project, and will be described under the head of "Improving Missouri River from its mouth to Sioux City."

Money statement.

July 1, 1882, amount available	\$1, 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	1, 00

U 12.

IMPROVEMENT OF MISSOURI RIVER AT BROWNVILLE, NEBRASKA

No special appropriation having been made for this place, and the importance of the work not being deemed sufficiently great to justify an allotment from the general appropriation, it was closed up and the property transferred to Saint Joseph.

Money statement.

July 1, 1882, amount available	\$43
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	43

U 13.

IMPROVEMENT OF MISSOURI RIVER, AT EASTPORT, IOWA, AND NEBRASKA CITY, NEBRASKA.

No special appropriation was made for the continuance of this work, but an allotment from the general appropriation having been authorized, operations have been in progress which will be described under the head of "Improving Missouri River from its mouth to Sioux City."

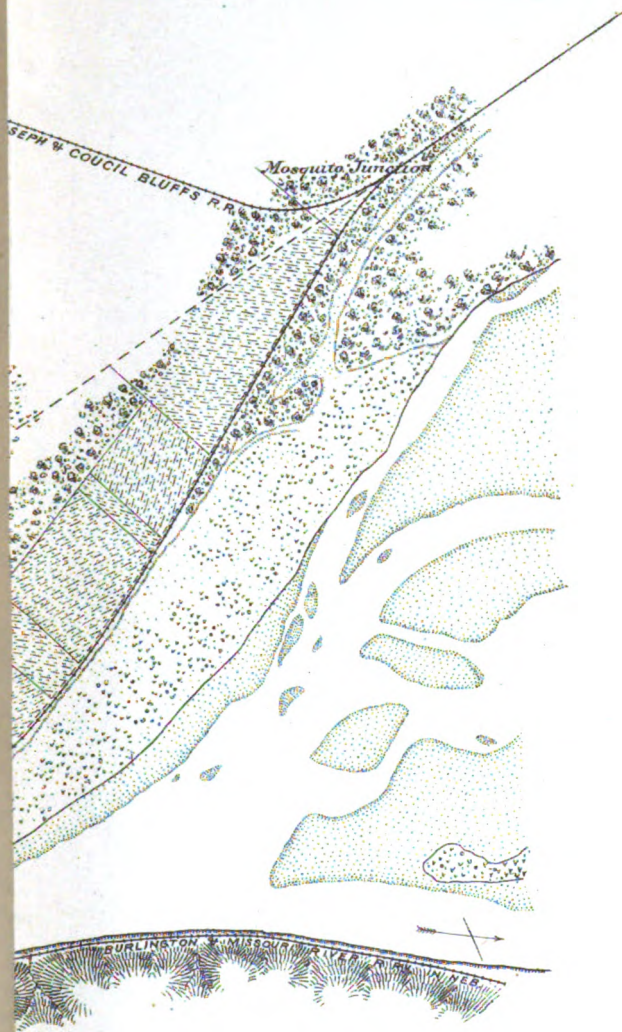
Money statement.

July 1, 1882, amount available	\$26
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	26

U 14.

IMPROVEMENT OF MISSOURI RIVER AT PLATTSMOUTH, NEBRASKA.

No special appropriation having been made for this place, and the importance of the work not being deemed sufficiently great to justify an allotment from the general appropriation, it was closed up and the property transferred to Nebraska City, Nebr.



U. S. Engineer Office
 St. Louis, Mo. August 13. 1883
 Report to the Chief of Engineers with annual report for 1883.

Chas. R. Suter
 Maj. of Engrs. U.S.A.

Money statement.

July 1, 1882, amount available.....	\$1,461 19
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	1,461 19

U 15.**IMPROVEMENT OF MISSOURI RIVER AT COUNCIL BLUFFS, IOWA, AND OMAHA, NEBRASKA.**

No special appropriation was made for the continuance of this work, but an allotment from the general appropriation having been authorized, operations have been in progress which will be described under the head of "Improving Missouri River from its mouth to Sioux City."

Money statement.

July 1, 1882, amount available.....	\$9,563 95
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	9,563 95

U 16.**IMPROVEMENT OF MISSOURI RIVER AT SIOUX CITY, IOWA.**

No special appropriation was made for the continuance of this work, but an allotment from the general appropriation having been authorized, operations have been in progress which will be described under the head of "Improving Missouri River from its mouth to Sioux City."

Money statement.

July 1, 1882, amount available.....	\$481 92
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	481 92

U 17.**IMPROVEMENT OF MISSOURI RIVER AT VERMILLION, DAKOTA.**

At the date of my last annual report a pile dike 8,000 feet in length had been constructed at a point about 14 miles above Vermillion, on the right bank of the river. This work accomplished some very satisfactory results, but, having been extended more rapidly than fill behind it could take place, the lower end required frequent repairs during the season. Operations were suspended in August on account of low water, and on October 12 the charge of the work was by your order turned over to Capt. Edward Maguire, Corps of Engineers, United States Army.

Money statement.

July 1, 1882, amount available.....	\$4,511 81
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	4,495 67
October 12, 1882, amount transferred to Capt. Edward Maguire, Corps of Engineers.....	16 14

U 18.

SURVEY OF THE MISSOURI RIVER FROM ITS MOUTH TO FORT BENTON,
MONTANA.

The late date at which the appropriation was made available did not permit parties' taking the field before the month of September. By the close of the season the survey was extended from Fort Randall to Pierre, a distance of 192 miles. The results have been nearly platted.

During the year the maps of the river, scale 1 mile to the inch, from the mouth to Fort Randall have been published, and it is expected to publish the remaining seven sheets to Pierre as soon as reduced.

The balance remaining has not been sufficient to warrant sending a party into the field this season, as the expense of organizing and sending a party so far would be out of all proportion to the results accomplished in a short season's work. Hence the prosecution of this important work will be deferred until sufficient funds are available to maintain a field party throughout the season.

Should money be available to resume the survey early next spring, so as to utilize the entire working season, at least 500 miles could be covered at a cost of \$50,000, and this amount is demanded by the interests of economy.

This work was in charge of Assistant D. W. Wellman, whose report is appended.

Money statement.

July 1, 1882, amount available.....	\$346 01
Amount appropriated by act passed August 2, 1882	40,000 00
	<hr/>
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	40,346 01
	24,733 97
	<hr/>
July 1, 1883, amount available	15,612 04
	<hr/>
Amount (estimated) required for completion of existing project	65,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	50,000 00

REPORT OF MR. D. W. WELLMAN, ASSISTANT ENGINEER.

SAINT LOUIS, Mo., June 30, 1883.

MAJOR: I have the honor to submit herewith the following report of progress on the survey of the Missouri River from its mouth to Fort Benton, Montana, for the year ending June 30, 1883:

At the date of my last annual report no appropriation for the ensuing year had been made, and the funds applicable to the work were practically exhausted.

On July 25 three of the assistants, for want of money to pay them, were discharged, and the remaining one on July 31. The three, however, continued on working without pay until August 10, when a new appropriation was made available, and the discharged assistants were again employed.

As soon as practicable after that date (August 10) some necessary repairs were made to the steamer Missouri, and a field party organized. On the 26th of the month the party left Sioux City on board the steamer for the point of commencement of the season's field-work, which point was not definitely decided on at the time of starting. It was thought that above Fort Randall, the highest point to which the survey had then been carried, work could not be prosecuted later than November 1 without dan-

ger of being caught in the ice. This, deducting the time required to go and come, would leave less than two months for actual field-work. The distance to Fort Pierre had been estimated at 209 miles. On the way up, however, a sketch of the river above Fort Randall was made—distances from point to point being estimated—by which the distance from Fort Randall to Fort Pierre was estimated at 186 miles. One hundred miles per month being taken as the average monthly progress of the survey, Fort Pierre was accordingly decided on as the starting point, and work was begun at that place on September 5, the party having arrived at the place at 11 o'clock of that day.

The weather proved very favorable, and somewhat more rapid progress was made than was anticipated. On September 29 the survey had reached Chamberlain, Dak., a distance by the shore-line measurements of 102 miles, and on the 21st of October connection was made with the work of the previous year at Fort Randall.

The total distance, as measured along the shore-lines, from Fort Randall to the town of Pierre, which is on the east side of the river and nearly opposite the town of Fort Pierre, is 192 miles.

At Fort Randall two assistants and two men were detached to obtain additional topography needed to complete the outline of the valley between that point and Sioux City. This party finished their field-work November 2.

Leaving Fort Randall with the steamer on the afternoon of October 21, and arriving at Sioux City on the 24th, the party, excepting two assistants, clerk and watchman on the steamer, were discharged, and the steamer hauled out on the Nebraska side of the river and blocked up ready for the repairs, the nature of which were indicated in my letter from Chamberlain, Dak., of September 29, 1882.

The organization of the party for the season was as follows, being similar to that of the year previous:

One triangulation party, consisting of one assistant in charge, three assistant engineers (one to assist in locating triangles and two to read angles), four axmen, and two boatmen.

Two shore parties, each consisting of one assistant engineer, one rodman, two flagmen, one axman, and one boatman.

One island party, consisting of one assistant engineer, two rodmen, two flagmen, one axman, and two boatmen.

Two level parties, each consisting of two assistant engineers, two rodmen, one axman, and two boatmen.

One sounding party, consisting of one assistant engineer, two leadsmen, and four boatmen.

One compassman, for topographical work on both shores.

On board the steamer were: Assistant engineer in charge survey, one clerk, one computer, one pilot, one engineer, one mate, one carpenter, one fireman, one watchman, two cooks, one helper, four deck-hands, two extra men, three waiters, one laundress.

Total number in party, seventy-four.

The work was carried on in a similar manner to that of 1881, except that this season one compassman was employed to locate bluff lines and outlines of timber and other topographical features when such were out of reach of the shore parties. This work was done by the compassman alone, taking bearings with a small compass and pacing for distances. Although necessarily rough, it was thought that the topography thus obtained would be substantially correct, and enable a fairly complete outline of the valley of the river to be shown on the maps. The result, however, has been somewhat disappointing. The distances shown in the notes are found to be in some localities from 30 to 50 per cent. too short, and but for the frequent connections with the shore and other lines this work would be of little value. By the aid of the connections, however, it is believed that an approximately correct delineation of the bluff line has been obtained.

The discrepancies noticed are probably due to the fact that the compassman, having to work on both sides of the river, and some days to traverse 10 or 12 miles of distance, much of the ground being very rough, was not always able to give to the details the time and care actually needed. Some work done in the same manner by two of the assistants below Fort Randall, one on each side of the river, proved quite correct and satisfactory.

About five days were lost on account of stormy weather, leaving thirty-six days on which work was done, and showing an average daily progress of over 5.3 miles.

As the river banks were quite free from brush or woods, this daily average could have been considerably increased, but for the difficulty that was found in keeping the triangulation work far enough in advance to at all times afford to the topographical parties such checks on their bearings and distances as are necessary to enable them to proceed with confidence. The consequence was that they were obliged frequently to resort to expedients to obtain checks, which involved the loss of more or less time.

This difficulty arose from the fact that this season, the valley being found of less

and more uniform width than below, and in order to give the triangulation work more permanency than had hitherto been attained, the triangulation stations were kept principally on the bluffs. This not only on account of the width from bluff to bluff, but the peculiar conformation of the hills necessitated a system of much larger triangles than formerly and scattered the triangulation party when working to the best advantage, to such an extent that frequently it was impossible to gather them up at night and get them and the topographical parties together, without taking some of them from their work so early in the day as to cause them to lose valuable time.

Another source of delay to the triangulation work is the liability of an observer to have to wait a half or even a whole day or more to get a sight to a flag that may be obscured by fog or the haze, so common in that region in the low-water season; or the position of which may be rendered uncertain by the frequent quivering motion in the atmosphere.

The topographical parties in the mean time, having shorter sights, experience no such difficulty, and are able to proceed with usual speed, and thus may even run ahead of the triangulation. In this way errors made in the topographical work are liable not to be discovered until the parties are too far away to permit of the work being re-examined on the ground. The result is, that for the last season's work the revision and correction of these notes has been a long and vexatious task. I recommend, therefore, that in future, in order to guard against the contingencies above mentioned, facilities be afforded the triangulation party for going ahead independently, and feel assured that the greater rate of progress that may be attained and the better quality of the topographical work will more than compensate for the small outlay necessary to carry out the suggestion.

The triangulation work of the past season is of a more permanent character than heretofore, and of excellent quality, considering the rapidity with which the work had to be prosecuted. Most of the stations in the main system are on the bluff proper, and all of them out of danger from caving banks. Prime-numbered stations were planted along the shores at suitable distances, as checking points for the topographical parties. All of the main stations are marked by a pit, about $1\frac{1}{4}$ feet deep, and mound of earth or stones, or referred by bearing and distance to nail-heads in trees or other permanent objects, so that most of them can probably be found for several years to come.

A piece of $1\frac{1}{4}$ -inch gas-pipe 2 feet in length, the top even with the surface of the ground, marks the angle point.

Great care in reading the angles was insisted on, as the following extract from the instructions to observers, prepared by Assistant Hart Vance, in charge of triangulation work, will show:

"Of every essential angle in the system a cumulative series of at least three readings will be taken, and when there is a material difference between any of the stations forming an angle the telescope will be reversed and another series read, the mean result being considered the measure determined.

"Each setting in these series will be carefully observed and recorded, and if the readings disagree, the series will be continued or the plates reset and a new series taken, until the observer is assured of the accuracy of the result to within ten inches.

"These angles should be observed and recorded in order, beginning with that farthest up-stream and working successively to the last one down-stream. When this is done the total angle between the extreme points observed will be taken in the manner already prescribed for essential angles. Then if the fourth flag in any quadrilateral be visible, the angle between that and each of the other two will be read and recorded as directed in the case of essential angles.

"When satisfied of the accuracy of his reading, the assistant observing one angle in a triangle will signal it (see signals) to the opposite assistant, who will add the three angles and signal back 'all right,' if the sum differs less than 20 seconds from 180 degrees, or 'repeat' if the difference be 20 seconds or more.

"When the triangles have been as far as possible checked in this manner, courses to all flags observed will be calculated and recorded in the note-books and conspicuously on the station."

A line of careful levels was run along the right bank, permanent bench-marks established, and elevations of the bank and water surface taken every 1,000 to 1,500 feet. No hard rock in place was found near the river, consequently most of the bench-marks had to be made on roots and bodies of trees; nine were made on large granite boulders.

The level work was done in a similar manner to that in 1881, namely, by two parties, each consisting of two levelers (one to check the work of the other) and complement of men.

These parties, by dividing the estimated length of the day's work, were able to give to the details all the care and attention necessary to insure good work, and to keep pace with the balance of the survey.

For accuracy, the work done by these parties, as shown by the system of checks, compares favorably with any similar work of which I have seen a record. The line

of check-levels, which was run independently from the commencement to the end of the survey, differed from the main line as follows:

At B. M. 12, 15 miles + 0'.051; greatest difference at B. M. 7 = + 0'.074.
 At B. M. 29, 44 miles + 0'.082; greatest difference at B. M. 22 = + 0'.092.
 At B. M. 44, 80 miles + 0'.088; greatest difference at B. M. 42 = + 0'.094.
 At B. M. 59, 111 miles + 0'.083; greatest difference at B. M. 52 = + 0'.099.
 At B. M. 75, 138 miles + 0'.131; greatest difference at B. M. 75 = + 0'.131.
 At B. M. 83, 162 miles + 0'.134; greatest difference at B. M. 78 = + 0'.142.
 At B. M. 91, 190 miles + 0'.154; greatest difference at B. M. 87 = + 0'.156.

In the year previous the greatest range of difference in 179 miles was from—0'.026 to + 0'.083, as follows:

At B. M. 12, 13 miles — 0'.010; greatest difference at B. M. 8 = + 0'.012.
 At B. M. 21, 32 miles + 0'.031; greatest difference at B. M. 16 = — 0'.017.
 At B. M. 29, 46 miles + 0'.048; greatest difference at B. M. 27 = + 0'.082.
 At B. M. 44, 80 miles — 0'.026; greatest difference at B. M. 31 = + 0'.034.
 At B. M. 52, 103 miles + 0'.043; greatest difference at B. M. 52 = + 0'.043.
 At B. M. 64, 128 miles + 0'.082; greatest difference at B. M. 64 = + 0'.082.
 At B. M. 77, 152 miles + 0'.072; greatest difference at B. M. 75 = + 0'.075.
 At B. M. 87, 179 miles + 0'.060; greatest difference at B. M. 78, 79, 86 = + 0'.083.

These results are doubtless due, not only to the skillful manipulation of the instruments, but to a rigid adherence to a systematic method of procedure, as set forth in the following extract from the instructions to levelers, prepared by Assistant Myron H. Phelps, who had charge of the level work in 1881 and 1882.

"The first and second leveler will use, when practicable, the same pegs; but no peg will be used by the second until the first shall have transferred his elevation from it. At least two settings of the targets will be made for each backsight and foresight, and no observation accepted as final unless checked within 0'.001.

"Full notes, with the exception of water and bank elevations, will be kept by the rodman. In checking with rodmen, the following system is to be invariably used. Except with regard to the final figure of the rod-reading, comparison will be made in elevation only. As the rodman approaches the instrument from the backsight, the leveler will call the elevation of the previous peg. As the leveler approaches the peg, the rodman will call the previous height of instrument. When a difference occurs, and it is found to arise from difference of record, re-examination will be made. A full record of all re-examinations will be kept by both rodman and leveler.

"The advance leveler will leave elevations on every third peg. As a general rule it is desired that the second leveler shall not check with the elevations left by the first until after his instrument is moved from the position used to determine the peg on which the comparison is made.

"Discrepancies on single sights of 0'.006 or more, and discrepancies on single sights in excess of 0'.001 per 100 feet of distance between pegs, will necessitate repetition; except that repetition will not be made for difference of less than 0'.003.

"If, on repetition, an error of or exceeding 0'.010 is found in the work of the advance leveler, the previous sight will be repeated in order to test the stability of the peg from which the backsight was taken.

"The computations of each day's work will be checked each evening by addition and subtraction. For this purpose the backsights and foresights between each bench and the one following it will be copied from the note-books, and the difference between their sums compared with the difference of elevation of the benches.

"Daily reports will be submitted embracing the following points:

"1. Distance run.

"2. Range of differences.

"3. Repetitions. Each repetition will be referred to by number of the pegs involved. A statement will be made of the size of the original discrepancy and of the amount of the error, if any, found by the leveler making the report.

"4. Range of check-sights. Information will be given of the number of times during the day when more than two target settings were required to secure a check. These instances will be classified according to the total range, as of 3, 4, 5, &c., thousands, and the number of target settings in each case will be given.

"All the books connected with the work will be submitted each Saturday night for inspection."

The instruments used were 18-inch V levels, made by Buff and Berger, and New York rods. The rods were provided with levels with which to determine their vertical position, and the targets with clamps and tangent-screws.

Gauges for marking rise and fall of water in the river were established at Fort Randall, Bijou Hills, Chamberlain, and Fort Pierre, and were read twice a day from the commencement of the survey to the end of November, when the readings were discontinued. As the river was quite low and remained at a very uniform stage during the months of September and October, the gauge readings, in connection with the levels, should give a close approximation to the low-water slope of the river over the surveyed portion.

It has been stated that the valley in this region was found to be narrower and of more uniform width than below. This change begins at Yankton, above which point to Fort Randall the mean width of the valley is about $1\frac{1}{2}$ miles. Between Forts Randall and Pierre it is little more than 1 mile.

The ledges of rather soft, friable rock, somewhat resembling soapstone, that are exposed wherever the river approaches the bluffs above Yankton, disappear at Fort Thompson, 107 miles above Fort Randall.

Above that point the bluffs, wherever they could be examined, are composed of a soft, finely laminated slate, readily disintegrated by the action of the atmosphere, and giving to the cone-shaped hills, whose summits are destitute of vegetation, the appearance of huge ash heaps. This disintegrated material, when mixed with water and allowed to settle, is to all appearance the same as the "gumbo" found in the river below, and is no doubt the source from whence the Missouri derives its color, and largely the matter held in suspension; as every shower must carry enormous quantities of it down the steep hillsides and ravines into the river. In fact, these bluffs, when excavated beyond where the action of the atmosphere is perceptible, are found to have exactly the character of the "gumbo" deposit in the river bottoms.

Two assistants have been steadily employed on the maps during the year; two others were also engaged on them after the close of field operations of last season, one until January 9 last, when he resigned, the other until May 1, when he was discharged, the amount of work yet to be done not being sufficient to warrant his retention.

The maps are now completed from the mouth to Fort Randall, and 1,000 copies on a scale of 1 inch to 1 mile have been printed for distribution.

Of the maps from Fort Randall to Pierre, of which there will be seven sheets, four are already finished, except plotting the soundings and profile of water-surface. The whole will be finished, reduced, and printed during the present summer. The work on the large sheets has been done principally by Assistant O. S. Willey, the reduction and preparation for printing by Assistant D. C. Humphreys. To both these gentlemen thanks are due for faithful and efficient services.

Congress at its last session having failed to make any appropriation for rivers and harbors, and the amount remaining of the last appropriation being too small to warrant any expenditure for field work the present season, arrangements have been made to reduce expenses to the minimum by retaining only such force as is necessary for the completion of the maps and care of the property. After the end of the present month, therefore, and until a further necessity arises, the total force employed will be one assistant in charge, one draughtsman, and one watchman on the steamer.

The steamer is blocked up in good shape, above ordinary high water, where it is proposed to let it remain and to defer the needed repairs until it is again required for service in the field.

The total distance now covered by the survey is 1,170 miles. From the best sources of information it is estimated that the distance yet to be surveyed—from Fort Pierre to Fort Benton—is about 1,100 miles. The field work on this remaining portion could easily be done in two seasons if funds were available as needed. For this and for the completion and publication of the maps I estimate that \$100,000 will be required, which would have to be appropriated in sums of not less than \$50,000, and this amount should be available each season as early as March 1 to enable a party to be started by April 15.

With your approval I propose to make a trip from Fort Pierre to Fort Benton this season in order to have a view of the river and valley, and be able to judge more intelligently of the kind of organization that will be required for the remainder of the work.

Appended is a table showing the low-water slope of the river between Pierre and Fort Randall, deduced from the levels and gauge readings; also table of distances on last season's work as made up from the shore-line measurements. These distances will be revised, and probably somewhat modified, when the large maps are completed.

Very respectfully, your obedient servant,

D. W. WELLMAN,
Assistant Engineer.

Maj. CHARLES R. SUTER,
Corps of Engineers, U. S. A.

Low-water slope, Missouri River, deduced from gauge readings of September 26, 1882.

Location of gauge.	Distance, gauge to gauge.	Fall.	Fall per mile.
	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>
Fort Pierre.....			
Chamberlain.....	101.0	90.688	0.898
Bijou Hills.....	42.5	41.791	0.983
Fort Randall.....	47.4	46.088	0.972

TABLE OF DISTANCES FROM MOUTH TO—

	<i>Miles.</i>
Fort Randall, Dak.....	978.8
Wheeler, Dak.....	1,007.6
Rosebud Landing, Dak.....	1,032.4
Bijou Hills, Dak.....	1,036.6
Brulé City, Dak.....	1,053.7
Mouth White River, Dak.....	1,055.7
Brulé Agency, Dak.....	1,063.6
Chamberlain, Dak.....	1,068.7
Fort Hale, Dak.....	1,078.9
Fort Thompson, Dak.....	} 1,086.0
Crow Creek Agency, Dak.....	
Foot "Big Bend," Dak.....	1,095.6
Head "Big Bend," Dak.....	1,119.8
Medicine Creek, Dak.....	} 1,132.0
Old Red Cloud Agency, Dak.....	
Rousseau, Dak.....	1,154.3
Pierre, Dak.....	1,170.7

U 19.

IMPROVEMENT OF GASCONADE RIVER, MISSOURI.

During the past season snagging parties completed the removal of snags from Fredericksburg to the mouth and from Indian Ford to Deer Slough. Since the summer of 1880 the river has been completely snagged over twice, the result being to enable light-draught steamers to navigate the stream at all stages, where before only high-water navigation was possible and even that quite dangerous.

Some experimental dike-work of light piling was also constructed at Round Island. This was fairly successful, and probably some increase to the navigable depth may be obtained by this method. The nature of the stream, however, is such that any considerable increase of depth available for boats of any capacity can probably only be obtained by means of locks and dams.

This work was in charge of Assistant Thomas T. Johnston, whose report is appended.

This work is situated in the collection district of New Orleans, and the nearest port of delivery is Saint Louis, Mo. The nearest fort is at Leavenworth, Kans.

Amount of revenue collected at the port of Saint Louis, Mo., during the fiscal year ending June 30, 1883, was \$1,393,744.56.

Money statement.

July 1, 1882, amount available	\$534 31
Amount appropriated by act passed August 2, 1882	10,000 00
	<hr/> 10,534 31
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	10,025 69
	<hr/> 508 62
July 1, 1883, amount available.....	508 62
Amount (estimated) required for completion of existing project.....	25,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	25,000 00

1338 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

REPORT OF MR. THOMAS T. JOHNSTON, ASSISTANT ENGINEER.

SAINT JOSEPH, Mo., July 14, 1883.

MAJOR: I have the honor to submit the following, my annual report for the year ending June 30, 1883, of operations on the Gasconade River, Missouri:

Field operations commenced early in September, 1882, and continued until November 28, when stopped by a flood in the river.

The work of removing snags from the river extended over the whole period. The work was commenced at Fredericksburg, 9 miles above the mouth of the river, and continued to the mouth. The snagging parties were then sent to Indian Ford, 78 miles above the mouth, and work continued to Deer Slough, being completed there. Since the work on the river commenced, in the fall of 1880, all of the river below Indian Ford has been worked over twice for the removal of snags.

The result has been to enable small, light-draught boats and other craft to navigate the river at all times when it is not frozen. Previously this could not be done at any stage of the river with safety, and not all at or near low water.

The work of construction to improve or increase the navigable depth was commenced early in the fall of 1882, and continued till stopped by high water in November. It was all at Round Island, 7 miles above the mouth of the river, and the main obstacle to navigation in the lower part of the river. The dam in the right chute, constructed the year before, was repaired and strengthened. A training-dike was run from and near the left bank from the head of the left chute to straighten the channel and throw it out of a pocket in the left bank of the river. This dike consisted of piles, driven some 10 or 12 inches apart, so that gravel could pass between them with ease. As this dike progressed down stream the space between it and shore filled up rapidly with gravel, the deposit in some places coming within a few inches of the watersurface. The space was from 40 to 90 feet wide and about 5 feet deep. The result of this dike was all that could be desired, and made it possible to utilize for purposes of navigation the full depth of water, whereas previously the channel was so sinuous and divided that at low water only a few inches in depth was available for passage of boats.

The effect of the dam placed in the right chute the year before was to essentially close it at low water, the end desired.

The early flood in November stopped the work earlier than was anticipated and left considerable material, piles, on hand, which were placed on a high bank for future use.

The survey work done comprised a series of measurements of discharge of the river at various stages and over a sufficient range, on the gauge, to enable a fair determination of the variation of discharge with gauge-height. The curves and discharges have heretofore been submitted to you. A number of sections were sounded to be used for comparison with future surveys, but in view of the fact that the work has been closed, these have not been worked up.

All property pertaining to the works was transferred to Saint Charles, Mo., in February, as shown by property return of April 30, 1883.

Very respectfully, your obedient servant,

THOS. T. JOHNSTON,
Assistant Engineer.

CHAS. R. SUTER,
Major, Corps of Engineers, U. S. A.

APPENDIX V.

IMPROVEMENT OF MISSOURI RIVER FROM SIOUX CITY, IOWA, TO FORT BENTON, MONTANA—IMPROVEMENT OF YELLOWSTONE RIVER.

REPORT OF CAPTAIN EDWARD MAGUIRE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR PART OF THE FISCAL YEAR ENDING JUNE 30, 1883.

IMPROVEMENTS.

- | | |
|---|---|
| 1. Missouri River from Sioux City, Iowa, to Fort Benton, Montana. | 2. Yellowstone River, Montana and Dakota. |
|---|---|

SAINT PAUL, MINN., *March 17, 1883.*

GENERAL: I have the honor to submit the following reports on the works in my charge.

Very respectfully, your obedient servant,

EDWD. MAGUIRE,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

V I.

IMPROVEMENT OF MISSOURI RIVER FROM SIOUX CITY, IOWA, TO FORT BENTON, MONTANA.

The Missouri River is formed by the union of the Jefferson, the Madison, and the Gallatin, at what is called "The Three Forks," in about $111^{\circ} 30'$ longitude west of Greenwich and $45^{\circ} 52'$ north latitude. It flows in a general northerly direction to Fort Benton, thence in an easterly direction to Fort Buford, and thence in a general southeasterly direction to its mouth. At about 200 miles below "The Three Forks" commence the Great Falls, which separate the river into the two natural divisions, "Missouri River above the Falls" and "Missouri River proper." The latter portion is subdivided into the Rocky River, which we may suppose to be comprised between Benton and Carroll, and the Sandy River, from Carroll to the mouth.

MISSOURI RIVER ABOVE THE FALLS.

In 1872 Mr. Thomas P. Roberts, assistant engineer of the Northern Pacific Railroad, made an examination of this portion of the river. In 1880 there was made under my direction a survey from Stubbs' Ferry (12 miles from Helena) to the mouth of Sun River. No steamboat has ever been on this portion of the river.

The length of river surveyed was 130.7 miles. The additional length of 73 miles to "The Three Forks" is, from all accounts, as easily navigable as the upper portion of that surveyed. No definite low-water marks could be found. Roberts states that for a distance of 130 miles below Gallatin City the river at no point rises more than 7 feet in its flood-stage, and in the Long Pool, ending at Sun River, head of the falls, the greatest rise is not over 11 feet. Gauges were established April 10, 1880, and readings taken until November 6. A comparison of those readings with those taken on the river below Benton indicate that the water of April 10, 1880, was 0.5 foot above low water of 1874 as assumed for the lower river.

A very marked change occurs in the river near Gibson's Ferry, 75 miles below Stubbs' Ferry. Above Gibson's the slope and current are very great, while below Gibson's a deep, flat river presents no obstacles to easy and rapid navigation.

The discharge at Stubbs' Ferry for a stage of +0.5 foot was determined by gauging to be 3,770 cubic feet per second. The discharge just below the mouth of Sun River for a stage of +3.05 feet was found to be 19,425 cubic feet per second. The discharge of the river between Stubbs' Ferry and the Three Forks is about that at the former place. The three tributaries of any consequence below Stubbs' Ferry are Dearborn River, Deep Creek, and Sun River. At high-water stage of the Missouri the discharge of the Dearborn was 622 cubic feet per second. For a stage of +2.75 feet in the Missouri the discharge of Deep Creek was 1,800.5 cubic feet per second, and for a stage of +3.05 feet in the Missouri the discharge of Sun River was 4,269.5 cubic feet per second.

There is sufficient water for light-draught boats. The practical difficulties are the great slope and consequent rapid current and the narrowness of some of the chutes. From Stubbs' Ferry to the foot of Blackbird Ripple, a distance of $68\frac{3}{4}$ miles, there is an average fall of 3.89 feet to the mile. This comprises the canon section of the river. The obstructions are gravel shoals, in wide or divided reaches of the river, and bowlders. Between Stubbs' and Gibson's ferries there are fifteen places at which the depth at low water is less than 2.5 feet, and twenty-eight places at which the depth is less than 3 feet. Of the fifteen places there are three at which the shoal is short and smooth, and the water is barely less than 2.5 feet. No improvements have been estimated for at those places. From Gibson's Ferry to Sun River the slope is very uniform and about 0.49 foot to the mile. The river is sinuous, the cross-section very much larger than above, and the depth everywhere sufficient for low-water navigation.

Below is given a table of locations and estimated cost of improvements necessary to obtain a channel depth of 2.5 feet. The estimates are for dams of stone alone. The depth of 2.5 feet is considered sufficient for the demands of any commerce which may resort to this portion of the river. A possible landing for Helena freight is just below Twin Islands. From that point to Helena the distance is 17 miles. From Stubbs' Ferry to Helena it is 12 miles. Hence, with an additional land haul of 5 miles there would be saved a haul of 18 miles of the most difficult portion of the river, and improvements costing about \$17,000, or about one-third of the total cost of improving the 130 miles of river. From Twin Islands to Sun River, 112 miles, the cost of improving the river to a depth of 2.5 feet would be about \$33,000, or about \$300 per mile. Considering only the portions upon which these improvements would be made, the cost of the 47 miles from Twin Islands to the foot of Lone Pine (Half-Breed) Rapids would be about \$700 per mile.

Table showing slopes and location of improvements required, and estimated cost of same to obtain a 2.5-foot channel depth from Stubbs' Ferry to Sun River, in the Missouri River.

Locations.	Miles from initial point.	Excessive slope.			Improvement required.	Number of cubic yards.	Cost per cubic yard.	Estimated cost.
		Length.	Rate per mile.	Least depth.				
Trout Creek Ripple.....	1.3	2,640	6.86	1.6	Wing dams.....	1,181	\$4 50	\$5,314 50
Eldorado Shoal.....	8.5	1,080	8.02	1.5	do.....	807	5 50	4,438 50
Helena Cañon.....	14.0				Removal of rocks.....	75	10 00	750 00
American Shoal.....	16.0	3,300	6.01	2.0	Wing-dam.....	400	3 50	1,400 00
American Shoal.....	16.6			2.9				
Hilger's Shoal.....	17.1			2.3	Wing-dam.....	250	4 50	1,025 00
Twin Islands.....	17.3	2,640	8.38	1.7	do.....	740	5 00	3,700 00
								16,628 00
Proposed landing.....	18.0							
Gate Rapids.....	22.3	1,220	8.65	2.4	Removal of rocks.....	50	10 00	500 00
Cliff Rapids.....	24.9	1,960	8.89	2.8				
Bear's Teeth Rapids.....	26.1	1,430	18.61	2.3	Removal of rocks.....	200	10 00	2,000 00
Bear's Teeth Shoal.....	26.9	5,500	10.56	1.4	Closing dams.....	1,580	2 75	4,345 00
Island No. 40, Mandible Point.....	30.5			1.5	Wing and closing dam.....	2,760	2 75	7,590 00
Island No. 43, Mandible Point.....	31.1	2,000	12.51	2.3	Removal of rocks.....	20	10 00	200 00
Island No. 45, Mandible Point.....	33.5	2,900	9.50	2.3	Closing dam.....	1,560	3 00	4,680 00
Wide Ripple Island.....	36.9	8,880	5.42	2.3	do.....	1,220	4 50	5,490 00
Mitler's Island.....	38.5			2.5				
Mouth Little Prickly Pear.....	43.1	4,710	3.10	2.8				
Rock Creek Ripple.....	44.7	3,400	4.7	2.7				
Nettleton Ripple.....	45.1	1,250	6.37	2.3				
Cut Bank Island.....	46.0	2,850	5.35	2.4				
Dog Creek Ripple.....	47.7	2,300	6.66	2.4				
Jay Cooke Island.....	52.3	5,100	4.59	2.8				
Above De Lacey's Point.....	61.0	1,850	7.48	2.8				
De Lacey's Point.....	62.0	1,010	7.79	2.5				
Finnikin's Rapids.....	64.2	1,250	7.39	2.7				
Lone Pine Rapids.....	65.0	2,670	18.16	3.1	Removal of rocks.....	125	10 00	1,250 00
Scattering boulders above Lone Pine Rapids.....					do.....	200	10 00	2,000 00
Blackbird Ripple.....	68.3	4,340	5.44	2.8				
Island No. 118.....	69.7	1,850	4.85	2.7				
Steben's Ford.....	71.8	6,940	2.59	3.0				
Cottonwood Ripple.....	76.5	5,370	4.07	2.5				
Island No. 133.....	77.8	4,450	2.89	2.9				
Estimated cost.....								\$44,683
Contingencies.....								5,817
Total cost of improvements.....								50,000

The profitable use of steamboats is made questionable, as far as the river alone is concerned, only by the great slopes. The swiftest observed current was over a slope of 7.33 feet to the mile and was 5 miles per hour. The current at Lone Pine Rapids, having a slope of 18.16 feet per mile, is only 4.5 miles per hour for one-half mile.

The greatest slopes are given in the above table. From the head of Lone Pine Rapids for a distance of $2\frac{1}{2}$ miles there is an average slope of 9.77 feet per mile. For a comparison of the slopes with those of a stream of the same type which has been and is navigated, the Yellowstone affords an opportunity. The maximum fall of the Yellowstone (as far as surveyed) is for 33 miles below Fort Keogh at the rate of 4 feet per mile. The maximum fall for a distance of 68 miles (the length of the Missouri slope from Stubbs' Ferry to the foot of Blackbird Ripple) is 3.55 feet per mile, or 0.34 foot less per mile than for the Missouri.

A graphical comparison of the slopes exhibits the following: Both rivers show a succession of pools and rapids. The changes from one to the other on the Yellowstone are much more frequent. If the rapids are short, boats can run them by "spurts" or judicious "bottling-up" of stream, while an increased length, even with less slope, demands "laying lines." The volume of water in the Yellowstone is greater than in the Missouri, the discharge being, near Fort Keogh, for a stage of +0.24 foot, 6,014.85 cubic feet per second, while at Stubbs' Ferry, on the Missouri, the discharge for a stage of +0.5 foot was 3,770 cubic feet per second.

All through freight carried on the river above the falls would have to be portaged from Benton to Sun River, a distance of 45 miles, or from the foot of the falls to Sun River, a distance of 25 miles. The river from Benton to the foot of the falls may be navigated, but its great slope would render navigation difficult. It is thus to be seen that there would have to be two rehandlings of freight, one at Benton, or at the foot of the falls, and one at Sun River, and thus a great expense incurred. A railroad is either now being built or will shortly be built from Helena to Benton. I do not believe the river above the falls will ever be navigated by steamboats, except perhaps at some future day one or two small pleasure boats may be placed on the river for the benefit of tourists. The river is beautiful, and the adjacent country was in 1880 well stocked with game of all kinds. The scenery is grand beyond description. The almost vertical sides of the cañon rise to great heights, and are rendered very picturesque by the dark-green pines, the rocks of every possible shade, from pure white to dark purple, green, and black, and the vivid scarlet, yellow, and green mosses and creeping plants which here and there cover the faces of the rocks.

MISSOURI RIVER BELOW THE FALLS.

This portion of the river from Benton to Saint Louis is of great value and interest as a line of transportation, and must ever remain so. No matter how many railroads may be built in Montana, the river will ever serve as a line of transportation. But even if it should not, it will serve that great purpose of keeping down rates on the railroads.

My attention has been devoted principally to the "rocky" portion of the river, and this report in consequence refers mainly to that portion. Major Suter has made a study of the "sandy" portion, and his reports and methods of improvement are applicable to the portion above his district.

HISTORY OF THE NAVIGATION OF THE RIVER.

The following account of the early attempts to navigate the Upper Missouri is of interest.

Up to 1830 the American Fur Company still clung to their keel-boats, and dragged them by human labor from Saint Louis to the mouth of the Yellowstone. In that year Pierre Choteau and the other members of the company determined to try a steamboat. The boat was built at Pittsburgh, and in the spring of 1831 left that port for Saint Louis. It was called the Yellowstone, and drew 3 feet light and 5 feet loaded. It succeeded in reaching Fort Pierre in 1831, but low water prevented further progress, and it returned to Saint Louis. In 1832 it succeeded

in reaching Fort Union, at the mouth of the Yellowstone, with the annual supplies for that post. This success led to the building of another boat at Pittsburgh called the *Assinaboine*. This boat made its first trip in 1833, ascending to Fort Union and returning safely to Saint Louis. The trip was repeated in 1834 and 1835. In the latter year, after discharging its cargo at Fort Union, an experimental trip higher up the river was made, reaching the mouth of Poplar River. Here it was caught by the falling water and compelled to pass the winter. The next season, on its way to Saint Louis, it was destroyed by fire in the vicinity of Heart River.

The American Fur Company subsequently owned a considerable number of steamboats, and every year saw one or more ascend to the mouth of the Yellowstone. Several attempts were made to push still higher up the river, but with indifferent success, as only the *El Paso* succeeded in passing the mouth of Milk River, and that only a few miles. Keel-boats therefore continued to be used on the Yellowstone and on the Missouri, above Fort Union. But in 1859 a more determined effort was made. The *Chippewa* had been built for the company with especial reference to the difficulties to be surmounted above the Yellowstone. It had a stern wheel, being the first of that description ever employed on the Upper Missouri. The *Chippewa* left Saint Louis in the spring of 1859. It was considered doubtful whether it would be able to pass the shoals above the mouth of the Judith, and a large mackinac was towed behind to lighten it by unloading the freight destined for Benton. This was done just above the mouth of the Judith; the *Chippewa* passed on, and on the 17th of June arrived at the site of Fort McKenzie (Brulé), a few miles below Fort Benton. Here the voyage ended, and, rejoiced at having achieved a success so decided, Mr. Choteau started the boat for Saint Louis. The following year the *Chippewa* ascended to Fort Benton, accompanied by the *Key West*, and thus, in 1860, the present head of navigation on the Missouri River was first reached by a steamboat. Since then the number of arrivals at Benton has gradually increased.

NATURE OF THE NAVIGATION.

The conditions under which steamboats operate on the Missouri River in the transportation of freight and passengers are so totally different from those on Eastern rivers that their design in all senses has to conform to the necessities of the case. Persons who have never traveled on the Western rivers laugh at the idea of a great improvement in navigation being attained by making a free channel of 3 feet or 30 inches depth.

The prominent feature of the river with which this report is concerned is its shallowness, and hence it is the style of hull which is of main importance. The boats must be of very light draught, and hence their great length and width in proportion to their depth. The style of the hull varies in shape from the flat-bottom scow model to one possessing some elegance of proportions. But in general the sides between the ends of the forward and stern shears and the bottom of the hull are true planes, at right angles to each other. A cross-section of the hull near amidships will generally be a rectangle. It is necessary to make the bottom a horizontal plane from the fact that in shallow water the boat is constantly touching bottom, and often lies aground for hours at a time, in which case a large part of the boat's weight is supported by the river

bed. Hulls designed to carry are built with reference chiefly to buoyancy or total displacement. Their models vary widely from all the usual standard shapes, and are said to have been designed after the pattern of the mouth of the catfish. In some cases the model of the bow approaches very nearly a segment of a sphere tangent to the plane of the boat's bottom. The curves of the first few cross-sections conform closely to arcs of circles. Very little attempt at shear is made at the stern. Their width is made very great and their depth small in proportion to their length. Wood is the material used; the bottom and side planking, the main timbers and uprights, the keelson timbers, and all longitudinal beams being of well-seasoned oak. The floor timbers, decking, and bulkheads are made of pine on account of its lightness. The engines are placed at the extreme after end of the hull, and are coupled at right angles to the shaft of the wheel, which is much less in diameter than the wheels of a side-wheel boat, but extends nearly the whole width of the boat. This gives a great carrying capacity on little water. It is stated that a stern-wheel boat will carry a load of 1,000 tons on but little more than half the depth of water required by a side-wheel boat for the same load. It affords also a roomy deck for the storage of all kinds of bulky freight.

Another important feature of the boats is "the spars," which are used for lifting and dragging the boat over shoals.

The following table gives the cost, capacity, &c., of boats navigating the Missouri River above Bismarck in 1882:

Name.	Cost.	Horse-power.	Custom-house tonnage.	Tonnage on 3 feet draught.	Tonnage on 2 feet draught.	Tonnage to the inch.
Benton	\$25,000	325.42	394.08	181.9	55	14.0
Hulena	22,500	244.42	352.31	205.5	70	13.5
Butte	23,000	263.60	405.51	230.0	100	14.6
Black Hills	22,000	244.42	369.69	212.0	85	14.2
Dacotah	48,000	566.58	956.98	238.5	.....	26.5
Josephine	19,000	325.42	300.51	180.7	70	12.3
Big Horn	20,000	283.48	293.86	192.1	85	11.9
Rosebud	20,000	283.48	286.49	182.1	75	11.9
Nellie Peck	26,000	347.46	280.77	220.0	60	17.8
Far West	18,000	325.42	397.81	187.8	60	14.2
General Meade	15,000	204.48	171.46	200.7	90	12.3
General Terry	16,000	239.98	323.15	186.0	75	11.5
Peninah	20,000	278.32	500.44	140.0	90	16.7
Red Cloud	30,000	.....	355.90	153.0	.....	17.0
Key West	26,000	325.42	422.60	182.3	50	14.7
Wyoming	50,000	566.58	1,034.15	229.0	.....	25.5
Niobrara	10,000	159.04	250.78	109.0	40	7.7
Behan	13,000	204.48	288.62	186.0	75	12.3
Eclipse	19,000	258.80	295.98	182.1	75	11.9
Batchelor	18,500	244.42	318.00	195.6	90	11.9

From the above table it is to be seen that for a depth of water of 30 inches the navigation and commerce of the Missouri is of importance and value.

THE ROCKY RIVER.

The bed of the river is of gravel of various sizes more or less mixed with sand. During the flood stages the amount of sediment carried along is quite large, but at low-water stage the water is very clear. In September, 1882, the outlines of rocks and pebbles could be distinctly seen and followed in depths of 5 feet.

The width of the river varies from about 400 to 1,000 feet. The following table gives the widths every 1,000 feet of length for that portion

of the river which has been surveyed, and also the mean depths corresponding to those widths:

Table giving the width and mean depth of cross-sections of the Missouri River, taken each 1,000 feet down-stream from initial point, "Holmes' Rapids."

Channel distance.	Width.	Mean depth.	Channel distance.	Width.	Mean depth.	Channel distance.	Width.	Mean depth.	Channel distance.	Width.	Mean depth.
Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
0,000	716	2,893	28,000	506	4,735	62,000	804	2,724	95,000	470	6,854
1,000	587	2,843	29,000	506	3,562	63,000	820	2,328	96,000	615	4,477
2,000	516	2,806	30,000	540	4,561	64,000	830	2,174	97,000	706	3,483
3,000	442	2,917	31,000	517	4,990	65,000	225	1,938	98,000	762	2,725
4,000	155	*	32,000	599	4,739	66,000	428	2,431	99,000	552	3,312
5,000	430	3,980	33,000	559	3,175	67,000	675	3,431	100,000	565	3,969
6,000	428	7,871	34,000	410	3,229	68,000	493	4,886	101,000	513	4,983
7,000	548	6,712	35,000	458	4,236	69,000	583	4,600	102,000	620	4,262
8,000	465	7,857	36,000	543	4,594	70,000	700	3,255	103,000	605	5,658
9,000	460	6,500	37,000	680	3,855	71,000	720	2,782	104,000	762	2,641
10,000	627	4,334	38,000	585	3,009	72,000	708	2,774	105,000	611	3,211
11,000	860	2,619	39,000	420	4,873	73,000	685	2,500	106,000	616	4,211
12,000	219	4,160	40,000	448	6,787	74,000	485	4,746	107,000	600	2,845
13,000	104	*	41,000	546	5,922	75,000	490	6,064	108,000	575	3,437
14,000	268	1,438	42,000	594	4,877	76,000	445	714	109,000	605	3,090
15,000	360	4,020	43,000	875	1,869	77,000	580	374	110,000	658	3,058
16,000	315	1,657	44,000	480	2,300	78,000	695	386	111,000	500	4,133
17,000	118	4,637	45,000	372	4,150	79,000	750	261	112,000	723	4,024
18,000	240	1,900	46,000	547	3,688	80,000	650	285	113,000	750	2,632
19,000	408	5,845	47,000	454	3,500	81,000	620	327	114,000	515	3,687
20,000	490	6,733	48,000	480	3,277	82,000	615	340	115,070	562	5,880
21,000	700	2,792	49,000	534	4,377	83,000	680	452	116,300	684	3,255
22,000	357	3,367	50,000	545	4,170	84,000	545	264	117,000	568	3,856
23,000	225	*	51,000	612	4,344	85,000	540	297	118,000	122	2,680
24,000	556	4,174	52,000	464	6,093	86,000	530	338	119,000	717	3,141
25,000	588	3,108	53,000	512	5,764	87,000	480	478	120,000	810	3,071
26,000	516	5,619	54,000	560	4,270	88,000	624	3,305	121,000	997	1,942
27,000	586	3,684	55,000	1,006	2,062	89,000	400	3,792	122,000	250	1,785
28,000	700	3,148	56,000	506	2,675	90,000	485	4,420	123,000	400	3,311
29,000	636	2,773	57,000	382	2,975	91,000	597	4,806	124,000	586	3,686
30,000	683	2,535	58,000	448	5,998	92,000	558	4,788		581	4,053
31,000	583	3,253	59,000	618	6,277	93,000	623	3,821		570	3,695
32,000	567	3,065	60,000	602	4,184	94,000	523	3,888			
33,000	420	5,080	61,000	551	4,600		480	5,264			

* No soundings.

The obstructions to navigation are caused by shoals, due to excessive "widening out," or to a division of the stream into two or more chutes by bars or islands, and also to bowlders and rapids filled with bowlders. These bowlders are of all sizes, and of the following varieties:

First. Very smooth, close-grained, reddish-yellow sandstone, containing a large proportion of clay and some crystals. Specific gravity, 2.6; weighs 162 pounds per cubic foot.

Second. Friable gray sandstone, medium-sized grain. Specific gravity, 2.15; weighs 134 pounds per cubic foot.

Third. Blue-gray, fine-grained calcareous sandstone. Specific gravity, 2.7; weighs 168 pounds per cubic foot.

These bowlders are often found deeply imbedded in the gravel, and very difficult of removal. At some few places rock ledges were found.

The drainage area of the river from its sources to the mouth of the Muscleshell is 39,965 square miles; from its sources to Benton it is 24,103.5 square miles.

The mean temperature of the water during the working season, as observed in 1877, was: June, 57°; July, 66°; August, 71°; September, 60°; October, 49°. The temperature of the atmosphere varies from +115° (August 9, 1879) to -40° (January 17, 1875).

The rainfall of the Missouri Basin varies very much for different localities as well as for different years. The Chief Signal Officer and the

1346 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Surgeon-General, United States Army, kindly furnished me data from which I draw the following tables:

FORT LOGAN.

Years.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	Total
	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	
1873			.84	1.22	.32	1.20	2.04	1.10	.88	.42	.20	1.10	.....
1874	1.36	.06	.30	.00	.44	.00	2.06	1.57	.10	2.26	1.04	.38	9.57
1875	3.82	.12	.51					1.06	2.42	3.53	.50	.25	.....
1876	.83	.05	.30	.24	.53	.50	7.14	.86	1.78	3.50	1.00	.24	16.97
1877	.18	1.05	.60	1.00	2.06	2.27	3.68	1.20	3.18	4.3	1.02	1.15	17.82
1878	.20	.05	.25	.45	1.25	2.85	4.33	5.42	2.50	.62	.77	.35	19.05
1879	.50	.10	1.00	1.25	1.86	1.38	3.55	1.20	.25	.05	1.03	1.00	12.17
1880	.00	1.25	.15	.05	.45	1.45	2.58	.49	.92	.82	.60	.64	9.46
Mean	.98	.39	.49	.47	1.12	1.88	3.63	1.61	1.50	1.45	.77	.64	14.43

FORT BUFORD.

Years.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	Total
	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	
1866				.70	.08	.06	.42	1.27		2.54	.20	.30	.....
1867	.58	1.13	.26	.12	.33			3.21	1.97	2.39	.10	.46	.....
1868	.13	.65		.18	.46	.65	1.78	.86	1.62	.94	.27	.62	.....
1869	.55	.00	.32	.97	.31	.00	3.92	.77	.76	.81	.45	1.25	10.11
1870	.03	.25	.21	.19	.24	.45	2.43	.90	.55	1.10	.00	.72	6.07
1871	1.00	1.40	1.35	.00	1.48	1.55	1.12	1.75	2.44	1.45	3.25	.80	17.59
1872	1.04	1.57	.98	4.35	2.25	1.25	6.60	2.69	1.25	1.40	1.10	0.45	24.93
1873	.69	.01	.15	.20	.25	.19	1.80	1.02	.24	2.26	.25	.13	7.19
1874	.83	.30	.71	1.12	.73	1.83	1.39	3.46	1.48	3.05	.43	.45	15.78
1875	.20	.00	.13	.12	.09	.10	4.00	1.75	.00	3.95	1.05	.80	12.19
1876	.22	.13	.31	.00	.11	.13	4.50	2.94	.80	.00	.85	1.60	10.69
1877	1.75	.20	.00	.05	1.60	1.85	2.60	3.15		1.00	1.25	2.05	.....
1878	.00	1.28	.01	1.15	.14	2.15	4.75	2.80	2.93	.34	.00	.10	18.71
1879	.37	1.68	.10	.51	.21	.74	4.02	5.46	4.17	2.36	1.04	.90	21.56
1880	.66	3.08	1.98	1.10	1.17	1.84	2.54	3.45	1.27	1.48	.53	.22	16.82
1881	.38	.08	.26	.29	.66	.87	2.25	2.55	2.84	.11	2.66	.98	14.13
Mean	.56	.78	.48	.69	.65	.84	2.81	2.32	1.60	1.39	.93	.76	13.81

FORT SHAW.

Years.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	Total
	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	
1867	.28	.25		.23	.24	.97	1.46	3.69	.70	.37	.46	.80	.....
1868	.50	.40	.00	.25	.64	.10	1.60	1.57	.86	.18	1.33	.11	7.54
1869	.45	.37	.78	.53	.61	.23	1.09	1.43	.22	1.64	.54	.32	8.21
1870	.66	.27	.32	.46	.24	1.40	.48	.26	.00	.00	.30	.74	5.13
1871	.79	.96	.21	.36	.89	.41	.36	.39	1.74	.64	.92	.18	7.85
1872	.58	.59	.44	.67	.04	.50	3.38	.26	.38	.36	.22	.14	7.56
1873	.23	.28	.29	.20	.38	.08	1.06	1.14	.00	.24	.16	.08	4.14
1874	.36	.25	.62	.32	.05	.04	.83	1.71	.62	.68	.00	.05	5.55
1875	.75	.00	.18	.16	.18	.14	7.19	.20	1.66	3.01	.93	.26	14.66
1876	.28	.43	.70	.05	1.14	1.18	2.04	1.43	.85	.28	.44	.35	9.17
1877	.01	.00	.53	.32	.58	.95	5.74	4.43	1.52	.41	.82	.42	15.73
1878							3.10	4.98	.66	1.30	.00	.55	.....
1879	.06	1.17	.10	.28	.10	1.30	2.38	2.39	1.15	1.09	.05	.33	10.40
1880	.82	1.15	2.27	.47	.15	.35	1.46	3.76	1.67	1.23	.96	1.56	15.85
1881	.59	.04	.74	.39	.55	.64	1.29	1.52	1.23	.67	4.77	.76	13.19
Mean	.45	.44	.53	.34	.41	.50	2.23	1.84	.88	.81	.79	.44	9.85

FORT BENTON.

Years.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	Total.
	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	
1870	.26	.76	1.00	.42	.16	.06	2.41	.63	.80	.71	.32	.41	7.98
1871	.14	.22	.60	.88	.48	1.48	1.58	.11	.93	.10	.46	.71	7.09
1872	.65	1.24	.81	.32	.13	.06	.62	1.10	4.62	.71	1.82	.19	12.37
1873	.61	.59	.60	.65	.23	1.13	3.03	1.66	1.29	1.80	.57	.19	12.85
1874	.86	.12	.67	.10	.64	.43	2.98	2.11	.10	1.19	.47	.56	10.23
1875	.58	.60	.66	1.40	.25	1.04	1.50	2.57	2.17	1.19	.13	.71	12.89
1876	.81	.43	.69	.28	1.34	1.28	9.08	1.49	2.32	1.46	.89	.84	20.41
1877	.35	.09	.72	.11	.60	1.04	4.58	1.44	1.94	.80	.90	.43	12.96
1878	.45	.00	.30	.05	.30	3.24	5.25	2.26	1.31	.16	2.32	1.18	16.72
1879	.09	1.50	.22	.74	.14	1.86	4.08	4.08	1.96	1.56	.18	.60	16.43
1880	.06	1.40	.24	.64	.36	1.80	1.54	4.50	1.31	1.47	.40	.82	14.54
1881	1.26	1.56	2.46	.56	.29	1.15	1.43	3.46	2.28	1.18	1.82	1.64	17.62
1882	1.73	.07	.76	.38	1.09	1.22	.85	.13	.85	.27	2.59	.86	10.59
Mean	.60	.58	.69	.47	.46	1.15	2.96	2.03	1.68	.97	.94	.70	13.23

FORT ELLIS.

Years.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	Total.
	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	
1868													
1869	.91	2.88	1.15	1.25	2.90	3.13	5.91	2.65	.85	.88	2.12	.32	23.55
1870	.13	.63	.06	.11	.65	.54	.18	.61		.00	1.54	.40	
1871										1.21	.58	.83	
1872	.51	.86	.37	.78	1.53	.54	6.16	2.58	.49	2.73	1.58	1.04	19.17
1873	.45	1.04	.80	1.13	.85	.56	5.60	2.90	1.56	3.22	.66	.87	19.64
1874	1.07	1.19	.07	.27	1.13	.99	7.10	2.38	.21	2.32	.54	.28	16.53
1875	1.66	1.07	.48	.77	.76	1.11	4.02	2.39	.77	.40	1.16	1.50	16.09
1876	.00	1.40	.86	.94	1.06	1.40	6.03	3.34	.63	.87	.78	1.93	21.14
1877	.68	1.72	1.20	1.42	2.77	2.06	1.89	3.63	.48	.53	.38	1.64	17.90
1878	.30	.47	.87	1.82	2.20	4.24	7.12	8.01	1.16	.94	.28	2.05	33.18
1879	1.32	2.53	.83	1.17	2.25	1.44	1.74	1.94	.84	1.12	1.99	17.11	
1880	2.45	.07	1.03	1.01	2.50	2.62	2.94	3.03	1.16	.33	1.16	1.16	19.44
Mean	.81	1.40	.86	.94	1.56	1.77	4.40	3.02	.85	1.14	1.16	1.16	19.10

FORT ASSINABOINE.

Years.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	Total.
	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	
1880			.10	.30	.51	1.29	.79	2.44	1.72	2.91	.37	.22	
1881	.65	1.63	2.29	.70	.38	.21	.91	1.21	3.18	1.36	1.61	.73	14.86
1882	.48	.04	.24	.86	.65	2.84	1.55	1.18	1.41	.73	2.19	.57	12.64
Mean	.57	.83	.88	.45	.51	1.45	1.08	1.21	2.10	1.97	1.39	.61	13.15

HELENA.

Years.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	Total.
	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	
1880													
1881	.87	4.64	2.86	.51	.00	1.55	1.60	3.51	1.95	1.78	2.49	2.04	23.60
1882	1.27	.38	1.08	.87	.31	.94	.54	1.18	.31	.15	3.64	.26	10.43
Mean	1.07	2.51	1.97	.44	.16	1.57	1.13	1.72	1.04	1.10	2.04	1.18	15.98

Appended will be found the curves showing the rainfall at certain points in the Missouri Basin. It will be seen that the greatest precipitation, as a rule, occurs in May. The amount of precipitation during the winter months has a great effect upon the mean stage of the river. The summer rains soon pass off and the river falls rapidly to low-water stage. The fall rains are always anxiously looked for by steamboat men. Still the waters of the Missouri are for much of the season the product mainly of melted snow, contributed by the headwaters, with comparatively little loss by evaporation. This snow furnishes the larger portion of the volume of the river after June.

The lowest water known was that of last year (1882); next to that was the low water of 1869 and 1874. The steamboatman's idea of the stage of the river for different years is as follows:

- 1868. Fair steamboat stage.
- 1869. Very low.
- 1870. Not quite as good as in 1868.
- 1871. Very low in the fall.
- 1872. Good.
- 1873. Fair.
- 1874. Low.
- 1875. Short, good season; low in the fall.
- 1876. Unusually good.
- 1877. Fair.
- 1878. Good.
- 1879. Low.
- 1880. Good.
- 1881. Low.
- 1882. Lowest water known.

Now, referring to the precipitation for those years, it is to be seen that the navigable stage of the river is not dependent solely upon the annual precipitation, nor upon that for any particular portion of the year. For example, taking the year 1876, which was the best boating season of which we have a record, and we find that the annual precipitation was greater than for any other year, but that the precipitation for the snow-months November, December, January, February, and March, and for the low-water months July, August, September, and October, was much less than in 1882, the lowest water known; that the annual precipitation of 1876 was less than in 1878, while the precipitation for the snow and low-water months of 1876 exceeded that for the same period in 1878. The latter year was considered simply a "good one." It is impossible to draw any positive conclusion as to the stage of water from the record of the rainfall. Undoubtedly the temperature has a great influence in regulating the time of melting of the snow, and thus exerts an influence upon the stage of water. An excessive precipitation might be followed by an early, hot summer, and floods would be great, but of short duration, followed by a very poor boating stage.

The river generally closes about November 15, but for several days previously the ice runs heavily, and navigation may be said to usually cease about November 10. The dates of closing and breaking up of course vary for different portions of the river. At Fort Berthold, Dak., the break-up occurs as follows:

Years.	Month.	Years.	Month.	Years.	Month.
1846	April 19	1853	March 29	1860	March 29
1847	April 3	1854	April 8	1861	April 9
1848	April 8	1855	March 26	1862	March 31
1849	April 1	1856	April 3	1863	March 30
1850	April 5	1857	March 26	1864	April 9
1851	March 21	1858	April 15	1865	April 14
1852	March 26	1859	April 21	1866	April 11

At Bismarck, Dak., the break-up occurred as follows:

Years.	Month.	Years.	Month.	Years.	Month.
1870	April 6	1875	April 17	1879	March 29
1871	April 1	1876	March 25	1880	March 30
1872	April 15	1877	March 30	1881	March 30
1873	March 19	1878	March 14	1882	April 5
1874	April 13				

At the mouth of the Muscleshell the break-up occurred in 1874 on April 9, and in 1875 on April 10.

At Dauphin's Rapids in 1879 the break-up occurred March 25.

At Gallatin Rapids in 1881 it occurred on February 4, and in 1882 on March 26.

At Chimney Bend in 1880 it occurred on March 28.

It is stated the break-up at its headwaters occurs in the latter part of February. The ice usually gorges at several places in the river, and occasionally the bottoms are overflowed to a depth of 10 feet.

Throwing out of consideration the banking-up caused by gorges, the range between highest and lowest water of which we have records is, at Benton, 7.5 feet; at Dauphin's Rapids, 7.3 feet; at Gallatin Rapids, 9.76 feet, and at Carroll, 17.17 feet. A sheet of curves, plotted from such gauge-readings as we have, is appended.

THE DISCHARGE.

We have the following three well-known formulæ for the mean velocity:

GANGUILLET AND KUTTER.

$$V = \frac{z}{1 + x} \sqrt{RS}$$

$$Z = 41.6 + \frac{1.811}{N} + \frac{0.00281}{S}$$

$$X = \left(41.6 + \frac{0.00281}{S} \right) N$$

in which—

V = mean velocity.

R = hydraulic mean radius.

S = slope or sine of inclination of the water surface.

N = coefficient indicating degree of roughness of the wetted perimeter.

The following are some of the values given for N:

Rivers and canals in perfect order and free from stones and weeds ..	0.025
Rivers in moderately good order, having some stones and weeds ..	0.030
Rivers and canals in bad order, overgrown with vegetation and strewn with stones and detritus	0.035
Irregular beds and broken channels	0.050

D'ARCY AND BAZIN.

$$V = \sqrt{\frac{RS}{0.0008534 + \frac{0.00035}{R}}}$$

for sections in earth, and in which—

V = mean velocity.

R = hydraulic mean radius.

S = slope or sine of inclination of the water surface.

HUMPHREYS AND ABBOT.

$$V = \left(\sqrt{M + \left(\frac{225a \sqrt{s}}{p + W} \right)^{\frac{1}{3}}} - \sqrt{M} \right)^2 - M' \sqrt{V'}$$

But (Printed Papers Essayons Club No. II) "for streams larger than 50 or 100 feet in cross-section the term involving M' may be dropped." Hence we have—

$$V = \left(\sqrt{M + \left(\frac{225a \sqrt{s}}{p + W} \right)^{\frac{1}{3}}} - \sqrt{M} \right)^2$$

in which—

V = mean velocity.

a = area of cross-section.

p = wetted perimeter.

w = width.

S = slope or sine of inclination of water surface.

M = coefficient depending on the mean radius.

As not only each river has its own particular coefficient, but the coefficient varies for different portions of the same river, none of the formulæ for mean velocity have an entirely general application. Therefore, before selecting one for use the results given by the three formulæ will be compared with the observed velocities and the formula which gives the least mean error will be adopted.

There have been altogether ten gaugings made of the Yellowstone and Missouri rivers, which gave the following results:

Table No. 1.

No.	Locality.	a	p	w	R	S
1	Missouri.....	1626	424.5	424	3.830	0.0006817
2	Missouri.....	4082.8	621.08	620	6.574	0.0003686
3	Missouri.....	9888.25	1091.73	1090	8.906	0.000333
4	Yellowstone.....	3578.7	598.8575	597	5.9825	0.00015
5	Yellowstone.....	3703.9	610.057	609	6.0714	0.00015
6	Yellowstone.....	2634.8	486.28	485	6.0392	0.000186
7	Yellowstone.....	2372	465.842	465	5.0918	0.00622
8	Yellowstone.....	2550	444.87	442	5.7885	0.00022
9	Yellowstone.....	4788.68	651.087	650	7.8472	0.00027
10	Yellowstone.....	4787.53	640.35	639	7.4452	0.00028

Table No. 1—Continued.

No.	Locality.	M	N	Computed velocity.			Observed velocity.
				H. & A.	D. & B.	G. & K.	
1	Missouri.....	0.005919	0.05	3.085	2.844	1.9311	2.8186
2	Missouri.....	0.004828	0.03	3.509	4.182	3.4252	3.7415
3	Missouri.....	0.0042207	0.03	4.229	5.323	4.352	1.9633
4	Yellowstone.....	0.005007	0.025	2.442	2.498	2.460	3.6841
5	Yellowstone.....	0.0049786	0.025	2.663	2.524	2.485	3.5633
6	Yellowstone.....	0.0049883	0.025	2.807	2.792	2.737	2.3002
7	Yellowstone.....	0.0053632	0.025	2.976	2.696	2.648	3.2042
8	Yellowstone.....	0.0051046	0.025	2.857	2.939	2.875	3.0047
9	Yellowstone.....	0.0045968	0.05	3.436	3.862	2.006	1.6677
10	Yellowstone.....	0.0045464	0.05	3.494	3.969	2.061	1.6404

The slope used for No. 3 was not well determined, and the results will not be used in the comparison of the three formulæ. The errors of the computed velocities are given in the following table:

Table No. 2.

No.	Locality.	H. & A.	D. & B.	G. & K.
1	Missouri.....	0.7664	1.5254	0.3875
2	Missouri.....	0.2325	0.4405	0.3163
3	Missouri.....			
4	Yellowstone.....	1.0421	1.1861	1.2241
5	Yellowstone.....	0.9003	1.0393	1.0783
6	Yellowstone.....	0.5068	0.4918	0.4368
7	Yellowstone.....	0.5282	0.5082	0.5562
8	Yellowstone.....	0.1477	0.0657	0.1297
9	Yellowstone.....	1.7683	2.1943	0.3383
10	Yellowstone.....	1.8536	2.3286	0.4206
	Sum.....	7.7459	9.7799	4.8878
	Mean.....	0.8606	1.0867	0.5431

Therefore Kutter's formula will be used, the value of N being deduced for the locality of application. The values of N in Table No. 1 were assumed, but the values as deduced from the formula for mean velocity are as follows:

Table No. 3.

No.	Locality.	N.
1	Missouri (Stubbs' Ferry).....	0.041495
2	Missouri (Dauphin's Rapids).....	0.027227
3	Missouri (mouth Sun River).....	
4	Yellowstone (Fort Keogh).....	0.016195
5	Yellowstone (Fort Keogh).....	0.01701
6	Yellowstone (2 miles above Keogh).....	0.030281
7	Yellowstone (Diamond Island).....	0.020445
8	Yellowstone (Diamond Island).....	0.023835
9	Yellowstone (2 miles below Glendive).....	0.061356
10	Yellowstone (2 miles below Glendive).....	0.064425

Having determined the local value of N, it will be assumed as constant for all stages of the water at that locality. It is impossible for want of data to do otherwise.

The following table gives the slopes of a portion of the Missouri River as determined by levels taken at the water's edge on the banks. The surveys were made whenever the time could be spared from the work of improvement, and consequently were made at different stages of the

water. Hence, errors are committed in assuming the different results as correct for the continuous stretch during the low-water stage:

Table No. 4.

Locality.	No. of station.	Distance between stations in feet.	Fall between stations in feet.	S.
Head Gallatin Rapids	1			
Gallatin Rapids	2	895	0.77	0.000860325
Gallatin Rapids	3	1,004	1.81	0.001402789
Foot Gallatin Rapids	4	2,376	2.13	0.000896464
Head Bear's Rapids	5	6,198	2.03	0.000327525
Foot Bear's Rapids	6	822	2.33	0.002824554
Clear River	7	4,000	0.89	0.000222500
Clear River	8	1,000	0.68	0.000680000
Head Little Dog Rapids	9	3,840	0.54	0.000140635
Little Dog Rapids	10	1,560	3.08	0.001949867
Little Dog Rapids	11	2,423	1.35	0.000537100
Foot Little Dog Rapids	12	1,380	1.64	0.001188406
Clear River	13	4,847	0.57	0.000117596
Head Dauphin's Rapids	14	830	0.06	0.000072289
Dauphin's Rapids	15	840	0.54	0.000642867
Dauphin's Rapids	16	810	0.89	0.001098765
Dauphin's Rapids	17	350	0.69	0.001971428
Foot Dauphin's Rapids	18	1,140	3.95	0.003464912
Head McGarry's Bar	19	5,270	1.15	0.000218216
McGarry's Bar	20	2,800	2.54	0.000907142
Foot McGarry's Bar	21	710	1.22	0.001718310
Head Castle Bluff Rapids	22	2,940	1.42	0.000482993
Castle Bluff Rapids	23	970	1.34	0.001381443
Castle Bluff Rapids	24	1,595	1.23	0.000771160
Foot Castle Bluff Rapids	25	730	1.29	0.001767123
Clear River	26	1,545	0.61	0.000394628
Clear River	27	1,840	0.08	0.000043478
Clear River	28	1,890	0.95	0.000505319
Clear River	29	3,330	2.65	0.000793795
Head Chimney Bend Rapids	30	2,110	0.93	0.000393365
Foot Chimney Bend Rapids	31	1,305	2.11	0.001616858
Clear River	32	4,955	2.51	0.000506559
Clear River	33	1,750	0.18	0.000102855
Clear River	34	630	0.57	0.000904762
Head Lone Pine Rapids	35	1,395	0.33	0.000236559
Foot Lone Pine Rapids	36	495	1.04	0.002101010
Clear River	37	4,360	0.68	0.000155963
Head Sliding Bluff Rapids	38	890	0.46	0.000516854
Foot Sliding Bluff Rapids	39	360	0.75	0.002083333
Clear River	40	7,490	2.42	0.000323097
Head Magpie Rapids	41	1,850	1.36	0.001007407
Foot Magpie Rapids	42	2,050	3.12	0.001521961
Head Cabin Rapids	43	2,700	0.50	0.000185186
Foot Cabin Rapids	44	1,500	1.68	0.001120000
Head Bird's Rapids	45	5,160	1.06	0.000205426
Foot Bird's Rapids	46	3,180	3.15	0.000905508
Clear River	47	1,340	0.57	0.000426374

From this table we have as mean values for S: In stretches where there are islands or bars, 0.000248022; in clear river, 0.000437001; on rapids, 0.001591719.

Observations taken at Dauphin's Rapids in 1877 at a stage of 2.00 feet above low water, of 1874, give:

$$V=3.7415$$

$$S=0.0003686$$

$$R=6.574$$

Substituting these values in Kutter's formula we have, after solving the equation—

$$N=0.027227.$$

We have seen above that the mean value for S in stretches where there are islands or bars is 0.000248, and that will be assumed as the

slope at Ryan's Island. Then, from observations made at Ryan's Island, we have for a stage of 0.87 feet above low water of 1874:

$$V=1.9742$$

$$S=0.000248$$

$$R=6.987.$$

Substituting these values in Kutter's formula, we deduce:

$$N=0.0466465$$

The drainage area of the river for Dauphin's Rapids is 39,246.5 square miles=157,554,666,086,400 square inches.

The mean annual rainfall was:

Locality.	1880.	1879.
Fort Ellis.....	33.18	17.80
Fort Logan.....	9.40	18.17
Fort Shaw.....	10.40	.....
Fort Benton.....	14.54	16.48
Sum.....	67.52	47.40
Mean.....	16.88	15.80

Hence the total rainfall for Dauphin's drainage area for 1880 was 1,539,075,673,344 cubic feet; and for 1879 it was 1,440,604,007,040 cubic feet.

The following are the mean monthly gauge-readings at Dauphin's referred to low water of 1874:

Month.	1880.	1879.
January.....	68.37	38.26
February.....	40.06	32.57
March.....	60.33	33.75
April.....	18.90	32.17
May.....	102.56	56.74
June.....	223.29	167.14
July.....	194.06	95.42
August.....	58.88	19.36
September.....	21.09	2.71
October.....	13.74	1.92
November.....	13.01	-6.18
December.....	70.57	46.00

And hence for the mean daily stage we have 2.43866 for 1880 and 1.70836 for 1879.

The stage of water at Dauphin's Rapids when the gauging was made in 1877 was 2.00 feet above low water of 1874, and the hydraulic mean radius was 6.574, hence we have for hydraulic mean radius for the mean daily stage in 1880—

$$6.574 + 0.43866 = 7.01266.$$

and in 1879—

$$6.574 - 0.29164 = 6.28236.$$

And the wetted perimeter for 1880 will be 662.5225 feet, and for 1879 it will be 593.5272 feet, and hence we have for 1880 the area of the cross-section 4646.045 square feet, and for 1879 the area 3728.751 square feet.

Supposing, now, N and S to remain constant for the changes in depth

and substituting the values of R for 1880 and 1879 in Kutter's formula, we shall have for 1880—

$$V=3.9067,$$

And for 1879:

$$V=3.6286,$$

And substituting these values in the expression $Q=AV$, we shall have for the discharge per second, in 1880:

$$Q=18,150.70 \text{ cubic feet,}$$

In 1879—

$$Q=13,530.14 \text{ cubic feet,}$$

Or the total annual discharges for 1880 and 1879, respectively, are 573,968,695,680 cubic feet and 426,686,495,040 cubic feet. Hence the ratios of discharge to the rainfall were, for 1880:

$$\frac{573,968,695,680}{1,539,075,673,344}=0.373$$

And for 1879:

$$\frac{426,686,495,040}{1,440,604,007,040}=0.296$$

or the mean ratio is 0.3345.

The drainage area for Ryan's Island is 39,964.8 square miles, or 160,438,273,966,080 square inches.

The rainfall for 1882 was:

	Inches.
Helena	10.43
Fort Ellis	19.44
Fort Shaw	13.19
Fort Benton	10.59
Fort Assinaboine	12.54

or a mean for the basin of 13.24 inches. Hence the total rainfall of the drainage area for Ryan's Island for 1882 was 1,229,283,997,286 cubic feet.

The total rainfall for drainage area of Dauphin's Rapids in 1882 was 1,207,189,686,912 cubic feet.

The ratio of the rainfall for Ryan's Island to that for Dauphin's is—

$$\frac{1,229,283,997,286}{1,207,189,686,912}=1.0183.$$

Now, by observations at Ryan's Island on October 20, 1882, at a stage of 0.87 foot above low water of 1874, we have the discharge 7304.7 cubic feet per second, and the discharge at Dauphin's for the same date should be

$$\frac{7304.7}{1.0183}=7173.42$$

cubic feet per second.

On September 7, 1882, the stage of water at Dauphin's, referred to low water of 1874, was —0.55 foot. On September 14, 1882, the stage of water at Ryan's, referred to low water of 1874, was —0.28. At Benton the gauge readings show that the river was stationary from September 5 to September 10, the stage being —0.17. On September 14 at Benton the gauge read —0.29, and at Ryan's —0.28. As the stage at Benton had been stationary from October 7 to October 17, inclusive, we will, in default of readings, suppose it to have remained stationary to include October 20, or to be +0.50. At Ryan's on that date it was +0.87, hence

at Benton the stage was 0.37 foot lower than at Ryan's. Now, on September 7 at Dauphin's the gauge read -0.55 , and at Benton it read -0.17 . On September 14 at Benton it read -0.29 , or there had been a fall of 0.12 foot. Supposing the same fall to have occurred at Dauphin's, we shall have as the stage at that place -0.67 on September 14. But at Ryan's on September 14 the stage was -0.28 , and hence at Dauphin's the stage was 0.39 foot lower than at Ryan's. Now, at Ryan's on October 20, or date of gauging the river, the stage was $+0.87$, and hence we will assume the stage at Dauphin's was $+0.48$. We have seen above that for a stage of $+2.00$ feet at Dauphin's, $R=6.574$, and hence for a stage $+0.48$ we have $R=5.054$, and the area of cross-section $A=2413.169$ square feet.

Then from the expression $Q=AV$, or
 $7173.42=2413.169V$,
 we have

$$V=2.9726$$

Now, in order to determine the change in S we substitute in Kutter's formula for the mean velocity the values

$$V=2.9726 \quad N=0.027227 \quad R=5.054$$

and by successive approximations we find

$$S=0.00033214$$

for a stage of $+0.48$. But for a stage of $+2.00$ we had $S=0.0003686$, and hence we have a decrease in S of 0.00003646 for a fall of 1.52 feet. Assuming the rate of decrease to be constant for a continued fall, we shall have for the lowest water of 1882, or, a stage of -0.67 , the value

$$S=0.00030456.$$

To determine the mean velocity for the lowest stage of 1882 we have, then, supposing N to remain constant,

$$R=3.904 \quad S=0.00030456 \quad N=0.027227.$$

Substituting these values in Kutter's formula we shall find

$$V=2.3794 \text{ feet per second,}$$

and substituting in the expression $Q=AV$ the values

$$A=1439.912 \quad V=2.3794$$

we have as the discharge for the "Rocky River" at lowest known stage

$$Q=3426.14 \text{ cubic feet per second.}$$

HISTORY OF THE WORK.

I was placed in charge of the work of improving the Missouri River, above the mouth of the Yellowstone, March 21, 1877, and have continued in charge up to the present time. The district was increased by the addition of the river from the mouth of the Yellowstone to Sioux City, Iowa, in the fall of 1882.

In the latter portion of the river work had been done by Major Suter at Vermillion, Dakota, but the funds pertaining to the work at that

point had been exhausted when I took charge, and nothing further has been done except to keep a watchman in charge of the property.

Upon taking charge of the upper river I found that there had been three reports made upon the subject: one by Maj. Charles R. Suter, Corps of Engineers (Report Chief of Engineers, 1875), one by Capt. C. W. Howell, Corps of Engineers (Report Chief of Engineers, 1868), and one by Mr. Thomas P. Roberts, published by the War Department in 1872. Each of these reports recommended improvements in but general terms. As no detailed surveys had ever been made, it was impossible for them to do otherwise. They were all, however, definite enough to show that the work should be commenced in the upper portion of the river, within the first 300 miles below Benton, where the most serious obstructions to navigation consisted of a series of rapids. Of these rapids Dauphin's was mentioned in the reports as demanding the first attention, and the opinions of steamboat men as expressed to me coincided with that conclusion. In view of the above a party consisting of one assistant engineer, one recorder, one overseer, and twenty-three men was organized in Saint Paul and left for the scene of operations June 11, 1877, arriving at Dauphin's Rapids June 25. Mr. H. E. Stevens was the assistant engineer. He continued on the work until February 15, 1883, when he resigned to enter commercial life. I am indebted to him for very valuable assistance in carrying on the work both in field and office. Much of the good accomplished is due to the energy and ability which he brought to bear on the work.

The improvement has been continued each year since the commencement of it, and most excellent results have been attained. It has been carried on by hired labor and purchased in open market. For some time the country was infested with hostile Indians, and it was necessary not only to arm the parties but to have escorts of infantry. Most of the material has been purchased in Saint Paul and the men hired in Minneapolis, there being no markets for either suitable labor or material in Montana. In 1881 a small steamboat was purchased, and since then the work has been much facilitated. Bids for doing the work were advertised for in March, 1881, but not one was received, and the result was simply time lost and much inconvenience in consequence. The appropriations have usually been made late in the season, and hence delays in the work have resulted.

In carrying on the work the main idea has been to accomplish as much good as possible in a short time and to improve as great a length of river as possible. For this reason, and also for the reason that we have no surveys except such as could be made without interfering with the work of improvement, there has been no complete plan of work made, and estimates for the improvements cannot be made.

The work done may be summarized as follows:

At Dauphin's Rapids a channel 100 feet wide and 3,400 feet long was cleared of rocks, and a dam constructed at the head of the bar to close the right chute.

Rock removed from channel, 985.5 cubic yards.

Dam 703 feet long, containing 4,056 cubic yards of rock, 760 fascines.

The channel should be widened, but such work is not urgent. The least depth at lowest water, and that only in a very few places, is 30 inches, the remainder of the channel varying in depth from 3 to 5 feet. Boats properly handled now never have any trouble at Dauphin's Rapids.

At Cow Island all of the rocks were removed from the channel and three dams built. The upper dam contains 1,179 cubic yards of stone; the middle one 955, and the lower one 340 cubic yards of stone. The

improvements at this place are completed and a navigable channel of over 3 feet secured. Boats now experience no difficulty at Cow Island. The improvements have permitted the landing of freight above the islands, and the land-haul to Benton is thus greatly facilitated.

At Grand Island the left chute was closed by a dam of stone, brush, and gravel. In all there have been placed in the dam 2,199 cubic yards of stone and 1,133 fascines. Just above Grand Island a training-dam was built, 950 feet long, containing 378 cubic yards of stone and 81 fascines. At the foot of Grand Island a training-dam was built containing 628 cubic yards of stone, 56 cubic yards of gravel, and 534 fascines.

At Hammond's Island the right chute was closed by a dam 245 feet long, containing 596 cubic yards of stone, 914 fascines, and 192 cubic yards of gravel. At the lower point of Hammond's Island there was built a dam containing 120 cubic yards of stone, 367 cubic yards of gravel, and 406 fascines. The effect of these dams at Grand Island and Hammond's Island is a greatly improved and straightened channel. More work should be done just below Grand Island.

At McGarry's Bar a dam 565 feet long, containing 1,532 cubic yards of stone, was built. There is now a good depth of water on the bar, but the channel just above and below the dam should be cleared of rocks.

At Two Calf Island a dam was built closing the middle chute. The dam is 252 feet long, and contains 125 cubic yards of stone, 270 cubic yards of gravel, and 372 fascines.

At Snake Point a few of the prominent rocks were blasted down; a dam was built from the right bank across the shoal above the island. The dam is about 615 feet long, and contains 2,006 cubic yards of stone. The channel is greatly improved.

At Ryan's Island was built a dam 1,330 feet long, containing 419 cubic yards of stone, 2,399 cubic yards of gravel, and 2,797 fascines. The effect of the dam was immediate, giving a 3-foot channel.

At Holmes' Rapids a channel 100 feet wide and 3,500 feet long was cleared by the removal of 286 cubic yards of rock.

At McKeever's Rapids 16 cubic yards of rock were removed, leaving a clear channel 1,000 feet long and 100 feet wide.

At Gallatin Rapids a clear channel 100 feet wide and 2,100 feet long was made by the removal of 734 cubic yards of rock. A dam was built, and its effect is to materially aid boats in running the channel.

The bars at Kipp's and Pablos rapids were raked for a length of 1,000 feet, and a width of 100 to 200 feet. It will be necessary to build a series of wing-dams at each of those places.

At Castle Bluff Rapids a channel 100 feet wide was cleared of 388 cubic yards of rock. More work should be done here.

At the foot of a gravel bar one-half mile above Castle Bluff 71 cubic yards of rock were removed.

At Bear's Rapids the channel was cleared for 2,000 feet, most of the work being in a length of 500 feet; 499½ cubic yards of rock were removed. This channel is now in good condition.

At Bird's Rapids a fair channel has been secured at what was one of the worst places in the river; 63 cubic yards of projecting rock were blown down below the 3-foot curve and 114 cubic yards removed by the grabs. The channel should be widened at the foot by removal of rocks and a dam built at the head of the bar—possibly a second one above.

At Cabin Rapids there were only a few boulders, 24 cubic yards in all, lying in from 3½ to 5½ feet of water. They were removed.

At Magpie Rapids 131½ cubic yards of rock were removed from a channel length of 3,000 feet. Work in the way of "cleaning up" may be done here.

At Lone Pine Rapids 23 cubic yards of rock were removed. Cleaning up may be done here.

At Little Dog Rapids 442 cubic yards of rock were removed from a channel 100 feet wide and 5,100 feet long.

At Chimney Bend 318 cubic yards of rock were removed. More work is needed here.

A survey of the river has been made from Holmes' Rapids to the foot of Bird's Rapids, and also at Kipp's and Pablos rapids, at Dexter Chute, at Ryan's Island, at Trover and Buffalo shoals, at Hawley Island, at Snake Point, at Cow Island, at Grand Island, at Hammond Island, McGonnagal's Bar, and at Armell's Island.

A continuous survey of the river made at low-water stage is very necessary, and a small party should commence the survey at Benton early in the spring just after the break-up. Such survey could be made for about \$5,000.

As has been stated above, a survey of the river above the falls was made in 1880.

On September 3 of the same year work was commenced on the same portion. At Bear's Teeth Shoal three dams were built, or rather rebuilt, with 822 cubic yards of stone. The Montana Navigation Company some years ago attempted to improve this locality, and portions of the old dams were found in place. The depth on the shoal was increased by the work to full 2½ feet. At Bear's Teeth Rapids a channel 70 feet wide was cleared to a depth of 2½ feet scant by the removal of 93 cubic yards of rock.

At Lone Pine or Half-Breed Rapids a channel 100 feet wide was cleared by the removal of 106 cubic yards of rock.

All of the surveys have been plotted in the scale of 1 inch to 200 feet

PROPOSED WORK FOR NEXT SEASON.

It is proposed to build the necessary dams at Shonkin Bar, Brulé Point, Kipp's Rapids, at head of island just above Pablos Rapids, at Pablos Rapids, at shoal just above Arrow River, and at Bird's Rapids; to remove rocks from the channel at McGarry's Bar and through to the foot of Castle Bluff Rapids, at Sliding Bluff, and at Bird's Rapids. If there should be any time left it is proposed to "clean up" at Cabin, Magpie, and Lone Pine rapids.

The general plan of improvement by means of wing-dams consists in determining the length of dam necessary to produce at the head of the shoal such a banking up or increased head as will give 30 inches depth at the lowest known stage. Having thus determined the width of the new channel, that width is adopted for the entire shoal, and the other wing-dams are built out to the edge of the new channel, the distance between the dams being, as a rule, for continuous shoals one and a half the length of the up-stream one. Whenever found to be necessary the concave bank is protected by a facing of stone or brush, as may be most convenient.

To determine the length of the dam, or, in other words, the width of the contracted portion, the several formulæ of Cresy, of Eytelwein, of Weisbach, of Bresse, of D'Aubuisson, and of Debaube are used. The problem of the amount and nature of the swell, banking-up, or increased

head produced by the contraction of a stream by wing-dams, bridge-piers, &c., is extremely difficult of solution in a satisfactory manner. It is not susceptible of close analysis on account of its complication. The law governing the contraction and spreading out of the water, the effects of whirlpools, and of the friction of the fillets of the stream among themselves, are very imperfectly known, and yet play an important part. Hydraulicians do not agree as to the theories involved, nor even as to the effects produced under unvarying circumstances. All of the formulæ have been deduced from theoretical data more or less incomplete, and vary very much as to the results given by them. Yet, while to a great extent the length of the dam must be determined by actual experience and observation of the actual effects produced during the construction of the dam, still by the aid of the formulæ we may approximate to the length of the dam and thus save time by knowing approximately the amount of material which should be on hand.

The method of improvement by wing-dams as adopted for the upper Missouri may be best explained by taking a particular case—Pablos Rapids. Here the desired increase of depth is 0.5 foot. The distance between dams is not constant here, but is governed by the shoal, which is irregular in shape and is not continuous. The location of the first dam, A, is made and the width of the contracted portion of the river determined.

We have found that the discharge per second for the rocky river is

$$Q = 3,426.14 \text{ cubic feet.}$$

By measurement the area of the cross-section at the location of the dam A at low water is $A = 1,046.5$ square feet, and hence we have for the mean velocity per second before contraction—

$$V = \frac{Q}{A} = 3.2739 \text{ cubic feet.}$$

Creey's formula is:

$$H = \left(\frac{V^2}{2g} + SI \right) \left(\frac{A^2}{m^2 W^2} - 1 \right)$$

in which

H = increased head = 0.5 foot.

V = mean velocity = 3.2739.

$2g$ = double the acceleration of falling bodies at end of first second = 64.36.

S = crest of dam = 20 feet.

I = slope of water surface = 0.001313.

A = area of original cross-section = 1,046.50.

W = area of contracted cross-section = 1.941 b .

b = width of contracted cross-section.

m = coefficient of contraction, which, according to Eytelwein, = 0.85.

From this formula we have—

$$b = 335 \text{ feet.}$$

Weisbach's formula is :

$$Q = mb \sqrt[3]{g} \left[\frac{2}{3} \left((h + K)^{\frac{3}{2}} - K^{\frac{3}{2}} \right) + R (h + K)^{\frac{3}{2}} \right]$$

in which

Q = discharge per second = 3,426.14.

m = Eytelwein's coefficient = 0.85.

$2g$ = double the acceleration of falling bodies at end of first second = 64.36.

b = width of contracted cross-section.

H = increased head = 0.5.

$K = \frac{V^2}{2g} = 0.1665.$

V = mean velocity = 3.2739.

R = mean radius of original cross-section = 1.6737.

From this formula we have—

$$b = 298 \text{ feet.}$$

Eytelwein's formula is:

$$Y = \frac{V^2}{m^2} \left(\frac{W^2 h^2}{W^2 (h + y)^2} - 1 \right)$$

in which

Y = increased head = 0.5.

V = mean velocity = 3.2739.

$\frac{1}{m^2}$ = coefficient = 0.017.

W = width of original cross-section = 625.

h = mean radius of original section = 1.6737.

W = width of contracted cross-section.

From this formula we have—

$$w = 249 \text{ feet.}$$

Bresse, D'Aubuisson, and DeBauve give the same formula:

$$Y = \frac{Q^2}{2g} \left(\frac{1}{0.7225 l^2 h^2} - \frac{1}{L^2 (h + y)^2} \right)$$

in which

Y = increased head = 0.5.

Q = discharge per second = 3,426.14.

$2g$ = double the acceleration of falling bodies at end of first second = 64.36.

l = width of contracted cross section.

L = width of original cross-section = 6.25.

h = mean radius of original section = 1.6737.

From this formula we have—

$$l = 389 \text{ feet.}$$

The mean of the values given by the four formulas is 318 feet, which is the width adopted for the new channel.

The length of the Dam A will then be 307 feet. It will receive a crest of 20 feet, a slope of 2 on 3 up-stream, and 1 on 1 down-stream, and a height of 1 foot above low water.

On the map the actual soundings at the time of the survey are plotted. The reduction to low water is not accurately known, but is about 4 feet.

As suitable rock for dams is very scarce, it is proposed to use gunny sacks filled with gravel, staked in place, and covered with a thick layer of gravel.

COMMERCIAL STATISTICS.

The following is a classified schedule of exports and imports via the river, as far as could be learned:

EXPORTS, 1877.

Ore and bullion, 1,225 tons	\$918,750 00
Wool, 208,459 pounds	72,960 75
Buffalo robes, 50,512	202,048 00
Antelope, elk, and deer skins, 68,530 pounds	12,335 40
Bear skins, 61	305 00
Wolf skins, 2,034	7,051 45
Beaver skins, 6,703 pounds	6,703 00
Hides, 15,267	45,801 00
Mixed furs	2,150 00
Sheep skins, 1,482	• 592 80
Cattle, 112 head	2,240 00
Fort Macleod shipment, 595 tons	303,600 00
Cypress shipment, 350 tons	180,000 00

IMPORTS, 1877.

Montana freight, 4,648 tons	\$1,394,000 00
Canadian freight, 1,025 tons	310,000 00

The total value of the commerce of the river was \$3,458,536.60.

In 1878 the number of steamboat arrivals at Benton was forty-six. The freight carried up the river amounted to 8,764 tons, of an approximate value of \$2,631,300. The Government freight shipped from Yankton, Dak., for the river above Buford amounted to 261,131 pounds, and the amount shipped up the river from Buford was 94,424 pounds.

The amount of wool shipped down the river was 696,000 pounds, and the amount of other articles of export was about the same as the previous year.

In 1880 there were shipped from Bismarck for points on the Missouri River 9,036,818 pounds of Government freight. From Yankton there were shipped to points on the Missouri River 2,595,132 pounds of Government freight, and from Buford there were shipped to points on the Missouri River 651,971 pounds of Government freight. The amount of wool shipped down the river was 600,000 pounds, and the amount of other articles of export was about the same as that for previous years.

RIVER FREIGHT, EXCLUSIVE OF EXPORTS AND INDIAN DEPARTMENT FREIGHT.

	Pounds.
Private freight	16,913,693
Government freight from Bismarck	9,036,818
Government freight from Yankton	2,595,132
Government freight from Fort Buford	661,971
Government freight from Cow Island	3,362
Government freight from Coal Banks	48,219
Government freight from Benton	48,845
Total	29,308,040
Or about 14,654 tons.	

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In 1881 five lines of steamboats made their headquarters at Bismarck, Dak., and twenty-one boats plied between that town and points on the Missouri River, making during the season of navigation from one hundred and fifty to one hundred and seventy-five trips. These boats carried into Montana 27,560,000 pounds of private and 7,200,000 pounds of Government freight, making a total of 34,760,000 pounds, valued at \$5,214,000. In addition, there were transported 1,300 passengers, 2,400 Indians, 1,800 head of horses and cattle, and 600 head of sheep. The exports, as far as learned, were as follows: 23,000 buffalo hides, valued at \$37,500; 180 tons wool, valued at \$90,000; 253,750 pounds of hides, pelts, &c., valued at about \$76,125, and also an unestimated quantity of furs and wolf skins.

In 1882 the number of steamboat arrivals at Benton was forty, the number of departures from Bismarck being eighty-six, and the number of arrivals at the same place being eighty-five.

The total shipment of freight from Bismarck was 32,194,041 pounds, of an approximate value of \$4,829,106. Of this amount 5,100,000 pounds was Government freight. There were 3,500 passengers and 1,200 troops transported.

The exports from Benton were as follows:

	Value.
Wool, 1,200,000 pounds.....	\$300,000
Cattle, 1,000	40,000
Bullion, 129,490 pounds.....	63,000
Beef hides, 7,600	34,000
Buffalo hides, 23,000	112,000
Bales, skin, 1,250	31,000
Bales, robes, 3,000	24,000
Merchandise, 44,681 pounds.....	8,930
Total	612,930

The total weight of these shipments was about 4,000,000 pounds.

The ports of entry are: Benton, Mont.; Poplar River, Mont.; Bismarck, Dak., and Omaha, Nebr.

During 1878, 1879, and 1882 I had the steamboat-channel distance measured going up stream as well as down. The distances, as finally adopted, are given in the following table, which will be of value to disbursing officers serving in this part of the country. The Pay and Quartermaster's departments constantly require the information contained in the table.

The distances from Kipp's Rapids to Fort Benton in the table are those given by Lieut. F. V. Greene, Corps of Engineers, from measurements taken in a mackinac. The distances between Bird's Rapids and Holmes' Rapids are from transit surveys made under my direction.

The distances were measured by boat survey, except between Bird's and Holmes' rapids, which were measured by a transit survey.

Missouri River distances from Bismarck, Dak., to Benton, Mont.

Places.	Place to place.	From Bismarck.	Places.	Place to place.	From Bismarck.
Bismarck Landing			Washburne	5.13	39.19
Bismarck Bridge.....	.50	.50	Fourteen Trees	7.34	46.53
Rock Haven.....	4.68	5.18	Fort Clarke	7.02	53.55
Foot Mountaineer Bend	1.99	7.17	Knife River	9.25	62.8
Head Mountaineer Bend	2.77	9.94	Coal Mine	2.05	64.8
Head Norwegian Bend	4.69	14.63	Towhead and Bluff.....	4.42	69.2
Wagonport.....	3.31	17.94	Winston's Landing.....	2.60	71.8
Square Butte.....	4.58	22.52	Job's Coffin	8.22	80.0
Head Painted Wood.....	6.56	29.08	Fort Stevenson.....	5.37	85.4
Turtle Creek.....	4.98	34.06	Emmanuel Rock	7.90	92.3

Missouri River distances from Bismarck, Dak., to Benton, Mont.—Continued.

Places.	Place to place.	From Bismarck.	Places.	Place to place.	From Bismarck.
Pat Connor's Point	2.71	96.07	Head of Bend No. 12.....	2.01	531.74
Berthold Lower Agency	5.57	101.64	Creek (R. B.) and Head of		
Fort Berthold	3.11	104.75	Bend No. 13.....	2.22	528.96
Pretty Creek (R. B.)	3.77	108.52	Head of Bend No. 14	3.41	527.37
Gros Ventre Island	9.56	118.08	Head of Bend No. 15.....	1.87	529.24
Foot Little Missouri Bend	2.15	120.23	Bouche's Grave	4.79	533.94
Creek (R. B.)	2.95	123.18	Head of No-Name Island.....	5.13	539.07
Little Missouri River	4.78	127.91	Champaign Creek	3.44	542.51
Rising Water Creek	10.02	137.93	Hell Creek	4.00	546.51
The Slide	6.18	144.11	Paradise Creek	6.31	552.82
Bone Point.....	4.13	148.24	Round Butte	5.91	558.53
Foot Maleury's Bend	5.10	153.34	Ruins	5.96	564.69
Indian Creek	10.88	164.22	Timber Creek	7.67	572.36
Creek (R. B.)	6.36	170.58	Buffalo Shoal	5.14	577.50
Towhead	2.57	173.15	Striped Hills Creek	2.42	579.92
Little Knife River	5.47	178.62	Katie Kounts Bar.....	1.75	581.67
Dougan's Tow-head	7.01	185.63	Trover Shoal	5.81	587.48
White Earth River	4.82	190.45	Trover Point.....	2.75	590.23
Strawberry Island	12.66	203.11	Fourchette Creek	2.22	592.45
Grinnell's Landing	3.16	206.27	Elk Island.....	6.58	599.03
Crow Bear Island	2.87	208.64	Head of Island	1.48	600.51
Tobacco Garden	4.66	212.30	Striped Bluff Rapids.....	3.06	603.57
David Watt's Bluff	3.30	216.60	Horse Shoe Point.....	2.49	606.06
Eclipse Harbor	13.46	230.06	Long Point.....	4.72	610.76
Sliding Bluff and Head of			Hornet's Nest Tow-head.....	1.53	612.81
Barker's Bend	6.62	236.68	Squaw Creek	2.29	614.60
Stoney Creek	12.59	249.27	Muscleshell River	3.46	618.06
Creek (R. B.)	3.69	252.96	Camp Loder	1.35	619.41
Old Mouth of Muddy	3.94	256.90	Hayfield	3.42	622.83
Muddy	4.51	261.41	Narrows	7.26	630.09
Scott's	3.97	265.38	Paul Maurice Stockade.....	1.51	631.60
Cut Banks	14.08	279.46	Hawley Station	2.90	634.50
Jordan's Farm	10.96	290.42	Hawley Island	1.50	636.00
Glaes Bluffs	5.01	295.43	Beauchamp Creek	2.15	638.15
Fort Buford	4.20	299.63	Kanuck Creek	6.01	644.16
Yellowstone River	2.14	301.77	Ryan's Island.....	5.11	649.27
Fort Union	5.19	306.96	Carroll	6.06	655.33
Little Muddy	14.36	321.32	Rocky Point	6.63	661.96
Big Horn Bluff	13.68	325.00	Chippewa Island	0.40	662.36
Beaver Dam Rock	6.20	341.20	Little Rocky-Creek	0.90	663.26
McKenzie's Bend	4.05	345.25	Sandy Creek	2.15	665.41
Big Muddy	4.74	349.99	Warm Spring Creek	1.88	667.29
Devil's Elbow	6.58	356.57	Harriet Island	4.14	671.43
Chardon Creek	9.72	366.29	Armell's Island	1.60	673.03
Frenchman's Point	1.30	367.59	Armell's Creek	1.85	674.38
Mortar Shell Hill	7.49	375.08	Two-Calf Island	5.74	680.12
Half Breed House	12.73	387.81	Foot Hammond Island	2.32	682.44
Towhead	2.65	390.46	Head Grand Island	1.75	684.19
Poplar Creek Agency	8.94	399.40	Dexter Chute	6.82	691.01
Redwater Creek	1.97	401.37	Head of Cow Island.....	5.83	696.84
Creek (R. B.)	6.84	408.21	Snake Point Island.....	2.25	699.09
Head of Nick Wall	1.80	409.81	Sturgeon Island.....	6.00	705.09
Marion Bend	2.68	412.49	Bird's Rapids	3.50	708.59
Head of Spread Eagle	7.13	419.62	Cabin Rapids	1.59	710.18
Creek (R. B.)	5.54	425.16	Magpie Rapids	1.16	711.84
Wolf Point Agency	6.70	431.86	Sliding Bluff Rapids	1.69	713.68
Creek (R. B.)	6.49	438.35	Lone Pine Rapids.....	1.05	714.08
Lower Dry	8.68	447.03	Old Chimney	2.05	716.13
Amelia Poe	9.67	456.70	McGarry's Bar	3.54	719.67
Porcupine Creek	5.53	462.23	Head Dauphin Rapids	1.99	721.66
Milk River and Foot of Chute.....	16.73	478.96	Head Little Dog Rapids	1.85	723.51
Head of Chute	1.09	480.05	Head Bear Rapids	1.94	725.35
Copeland Station	10.60	490.65	Head Gallatin Rapids	2.13	727.53
Dry Fork	4.83	495.48	Head McKeever's Rapids	1.13	728.66
Fort Peck	2.90	498.38	Head Holmes Rapids	3.03	731.69
Head of Bend No. 1	0.43	498.81	Judith Post-Office	3.86	735.05
Head of Bend No. 2	1.69	500.50	Judith River	0.40	735.45
Creek (L. B.)	2.40	502.90	Drowned Man's Rapids	2.50	737.95
Head of Bend No. 3	0.72	503.62	Arrow River	6.00	743.95
Head of Bend No. 4	3.20	504.82	Pablos Rapids	3.73	747.68
Head of Bend No. 5	1.30	508.62	Steamboat Rock	3.54	751.22
Head of Bend No. 6	0.84	509.46	Hole in the Wall	4.09	755.81
Head of Bend No. 7	1.58	511.04	Citadel Rock	1.44	756.75
Creek (R. B.) and Head of			Kipp's Rapids	1.57	758.82
Bend No. 8	2.06	513.10	Little Sandy	17.48	775.75
Head of Bend No. 9	2.06	515.16	Coal Banks	5.00	790.75
Head of Bend No. 10	2.17	517.33	Maria's River	17.80	798.56
Head of Bend No. 11	2.40	519.73	Fort Benton	17.70	816.25

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IMPROVEMENT OF YELLOWSTONE RIVER, MONTANA AND DAKOTA.

HISTORY OF THE WORK.

By a letter dated July 8, 1878, from the office of the Chief of Engineers, I was directed to submit a project for a survey of the Yellowstone River. The project having been approved, the sum of \$15,000 of the amount appropriated for examinations, surveys, and contingencies of rivers and harbors by the act of Congress approved June 18, 1878, was made available for the purpose. Accordingly two parties, each consisting of two transit men, one leveler, one recorder, and fourteen men, were placed in the field, one at the mouth of Powder River and the other at Fort Keogh.

The sum of \$4,000 of the amount appropriated by the act of Congress of March 3, 1879, was made available for continuing the survey. A party consisting of one transit man, one leveler, and nine men was placed in the field at Terry's Landing, August 11, 1879.

The work of improvement of the river was commenced at Buffalo Rapids in 1879, and has been continued each year until the present time

WORK DONE.

During the surveys of 1878 and 1879, the work accomplished was as follows:

Miles of river surveyed	256.45
Miles of developed shore-line	910.00
Number of sounding lines	4,712.00
Number of soundings	90,062.00
Number of sets of azimuth observations	38.00
Number of sets of gaugings	6.00
Daily progress of miles of river	3.05

The work of improvement was as follows:

At Buffalo Rapids a channel varying from 100 to 150 feet in width and 8,800 feet long was cleared. The slope has been very materially reduced and steamboats now experience no difficulty here. A dam was built at this place. The work done was:

Total length of dam and shore protection, feet	565
Number fascines made and placed	1,196
Number cubic yards rock quarried and placed	1,323
Number cubic yards gravel placed	553
Number cubic yards rock removed from channel	652.5

In addition a large amount of rock was blown down into deep water.

At Baker's Rapids a channel from 120 to 180 feet wide has been cleared to a depth of 3 feet at low water. Ranges were established and also a crib to which to lay a line.

Number of cubic yards rock removed	234
--	-----

In addition a large amount of rock was blown down into deep water. Steamboats now experience no difficulties at this place.

At Wolf Rapids a channel 300 feet long and 100 feet wide has been cleared to a depth of 3 feet. Steamboats now experience no difficulty at this place.

Number cubic yards rock removed	406
Number cubic yards rock blown down into deep water	313

At Edgerly's Island two dams were built, one 1,192 feet long, and the other 860 feet long.

Number fascines made and laid	3,722
Number piles cut and driven	502
Number cubic yards rock quarried and placed	2,850
Number cubic yards gravel placed	1,264

The effect of these dams has been a greatly improved channel with a least depth of 3 feet at low water.

On August 11, 1882, two parties, with Assistant Engineers Towar and Durage in charge, left Saint Paul for the Yellowstone River.

Work was commenced at Glendive Shoals August 23. These shoals extend over a distance of about 4 miles, commencing at the town of Glendive, and terminating about half a mile below the Old Cantonment. The work was commenced late in the season of 1881 by damming the left chute at the head of Katie's Island, opposite Glendive. The work on that dam was left incomplete in 1881 on account of the formation of a large ice-gorge above and on it. The work done was:

Total length of dam and shore protection, feet	545
Number fascines made and laid	1,391
Number piles cut and driven	151
Number cubic yards rock quarried and placed	485
Number cubic yards gravel placed	342

Last season this dam was strengthened and completed, and it has now a length of 710 feet, a base of about 50 feet, and a height above low water of 1.5 feet. It has turned the main volume of the water into the right chute, and the left chute has filled with gravel and silt both above and below the dam. There is a greatly improved channel, with a least depth of 3 feet.

The next place improved is about a mile below Glendive. Here the left chute was closed by a dam 516 feet long, with a base of 38 feet, and a height above low water of 1.5 feet.

About half a mile below the latter place the river flowed again in one channel, but continued to do so for only about half a mile, where it again divided into three chutes. The left one turned abruptly to the left, impinging against a soft-cut bank, and the shoal at the head was composed of hard, compact gravel, which would have cut but little if at all. There were also three ledges of rock in the channel, about midway between the head and foot, which would have been very difficult to remove. The right chute was narrow, of slight depth, and never navigable. Hence, these two chutes were closed by dams, and the whole volume of the river was confined to the middle channel, which has now least depth of 4.5 feet at low water, and the gravel bar at its foot had commenced to scour and wash down immediately after the dams were built. The dam closing the left chute is 950 feet long, has a base of 40 feet, and a height above low water of 1.5 feet. The dam closing the right chute is 203 feet long, has a base of 50 feet, and a height above low water of 1.5 feet.

The fifth and last dam built closes a chute about midway between the head and foot of the new channel. It is 516 feet long, with a base of 38 feet, and a height above low water of 1.5 feet. A few smaller protections for shores and low places where a scour might occur were made.

These dams were built in a manner similar to those built the previous season, a description of which was given in the report for that year. It is expected that the effect of these dams will be an unobstructed channel of 4½ feet at low water for a distance of 10 miles below Glendive.

Number fascines made and laid	6,806
Number mats made and laid	565
Number cubic yards of rock quarried and placed	2,003
Number cubic yards of gravel placed	2,533
Number piles driven	15

COMMERCIAL STATISTICS.

Last year there were no steamboats on the Yellowstone, except those belonging to the Northern Pacific Railroad, and which were employed in carrying the railroad material. It is doubtful if the Yellowstone above Glendive will ever again be of any importance as a line of transportation, unless the railroad company should exact too much. But that portion of the river from Glendive to the mouth should be improved and kept open. A navigable depth of $3\frac{1}{2}$ feet at low water can be obtained and maintained during the whole boating season, thus supplying a competing water-route of value.

LETTER OF MR. C. P. WOOLFOLK.

NORTHERN PACIFIC RAILROAD COMPANY, CONSTRUCTION DEPARTMENT,
Elketah, Mont., Division, November 17, 1892.

DEAR SIR: Yours of the 25th of last month came to hand yesterday from Bismarck, and contents noted, and in reply will say that the work done by you has been a great benefit to the navigation of the Yellowstone River. My first trip up this river was made in 1876, and I have been here every season since. I came into the river with the steamer Batchelor, on the 18th of April this year, and was seven days coming to Glendive. We found plenty of water on bars you had worked at; 3 feet at Glendive, where, in August, 1879, there was only 24 inches, and the same at Edgerly's Island. I came over the river ten days earlier than any boat before, and found all the places you had worked at in good condition. Had plenty of water at Wolf Rapids, also at Baker's. I, however, think you can do a great deal of good for the river below Glendive by working at Stanley's Shoals, Coulson Island, and several other places, and think you can make plenty of water for boats to run to Buford as late as they can to Cow Island, on the Missouri River.

Trusting you may keep on doing the good work, as you have done heretofore,

Yours, truly,

C. P. WOOLFOLK.

Capt. E. MAGUIRE,
Corps of Engineers.

APPENDIX V—Continued.

IMPROVEMENT OF MISSOURI RIVER FROM SIOUX CITY, IOWA, TO FORT BENTON, MONTANA—IMPROVEMENT OF YELLOWSTONE RIVER.

REPORT OF CAPTAIN JAMES B. QUINN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883.

IMPROVEMENTS.

- | | |
|---|---|
| 1. Missouri River from Sioux City to Fort Benton. | 2. Yellowstone River, Montana and Dakota. |
|---|---|
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UNITED STATES ENGINEER OFFICE,
Saint Paul, Minn., July 24, 1883.

GENERAL: I have the honor to forward herewith my annual report for the fiscal year ending June 30, 1883.

Very respectfully, your obedient servant,

JAMES B. QUINN,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

V 3.

IMPROVEMENT OF THE MISSOURI RIVER FROM SIOUX CITY, IOWA, TO FORT BENTON, MONTANA.

Charge of this work was transferred to me by Captain Maguire, Corps of Engineers, U. S. A., on the 15th of last April. Whatever work has been accomplished during the year has mainly been under his supervision.

Nothing was done on that portion of the river below Bismarck, Dak., the entire operations being limited to the improvement of the portion above that place and below Fort Benton.

The object of the work has been to secure a sufficiently deep and unobstructed channel through the difficult reaches to accommodate the existing commerce. To secure this object two methods of improvement were followed:

- 1st. The removal of obtruding rocks from the channel.
- 2d. The construction of wing dams in such positions as to confine the water in the desired channel, or back the water up in such a manner as to give deeper water over the shoal crossings above, and in several cases both methods were combined.

The results have proved very satisfactory to the steamboat men, and

It is quite apparent that still greater satisfaction will result from further work.

The character of the river bed, where operations have been carried on hitherto, is such as to guarantee the permanency of the work already done, or of that projected in this locality. The beneficial results so far obtained justify the continuance of this work to final completion.

Below the present field of operations the character of the river channel is entirely different; the bottom is sandy and shifting, and the banks lack stability. Although it is possible to greatly improve this portion of the river, anything of a permanent character or lasting improvement is hardly to be expected as possible with any reasonable expenditure of money. Such work will necessarily be of a temporary character—some light construction which can be speedily put in position—be easily and economically constructed, and easily repaired when damaged by floating objects.

PRESENT METHOD OF CONDUCTING THE WORK.

The impossibility of obtaining labor in the vicinity of the scene of operations has rendered it necessary to carry on the work with laborers shipped from Saint Paul, Chicago, &c., no contractor having yet been found willing to make a trial.

Two working parties, in charge of assistant engineers, have accordingly been sent out to the site of the work each year at about the beginning of the low-water season, and have continued in the field till freezing weather compelled a cessation of work. One of these parties was generally charged with the removal of rocks from the channel, and the other with the construction of wing-dams, but on some occasions both parties were combined.

The difficulties attending the supply of these parties with necessary machinery and appliances have been very great; frequent long delays have occurred, and some hardships resulted in consequence, although in every case ample allowance had been made for unforeseen delays or accidents.

* * * * *

In this connection it is proper to state that the several allotments for this work have been so small that, in order to accomplish anything at all, but little money could be spared for the purchase of suitable mechanical appliances, and, as a consequence, the aggregate cost of the work accomplished has been quite large; in fact, it is difficult to see how it could be otherwise under the circumstances.

INDUCEMENTS FOR FURTHER APPROPRIATIONS.

Between Sioux City, Iowa, and Fort Benton, Mont., there is nearly 2,000 miles of navigable river, and for nearly the whole of this distance the river flows through an exceedingly promising country, which is rapidly growing in population, and bids fair to require vastly greater facilities for the transportation of its produce in the immediate future than at present exists.

Between Sioux City and Bismarck the river is practically unimproved, and opposes considerable obstacles to the passage of steamboats, yet during the past year the steamboats upon this portion have handled 17,000,000 pounds of freight.

Above Bismarck, where the improvements have but just begun and navigation is still difficult, 32,000,000 pounds of freight were handled by the steamboats during the past year.

Upon both stretches of the river I have the strongest assurances

that the commerce of the present year will be largely in excess of that of last year, and that there is healthy promise of steady increase for the future, notwithstanding the difficulties of present navigation, which materially increases the cost of all articles transported by river.

Since transportation facilities materially affect the prosperity of any country, the future possibilities of this Missouri River Valley, when the channel of the river is suitably improved, hardly admits of speculative exaggeration. A country that improves so rapidly in the face of such difficulties has a wonderful future before it, and deserves all the assistance that may be extended to it to enable it to place its products on an equal footing with more favored localities in the markets of the world.

In no way can this object be so readily attained as by facilitating the means of transport, and thereby cheapen the carrying cost of produce to and from market.

PROJECTED IMPROVEMENT.

Throughout those portions of the river where the channel is formed in stable material the deepening and confining the channel, after the plan at present followed, is believed to be satisfactory in its results. For the economical prosecution of this work a good clam-shell dredge is necessary, and as the machinery could be placed on one of the derrick-boats, it should not cost over \$15,000. No further important addition to the plant will be required for this reach of the river.

For those portions of the river where the channel courses through shifting sands, and by caving banks changes its position with every flood or temporary obstruction, which for years will preserve a well-marked location, and then under the pressure of gorging ice or other temporary causes, totally change its position—that may appear upon one side of the river to-day and upon the other to-morrow—that is fickle even when held in the icy embrace of winter, there is required an application of measures which will have sufficient elasticity to accommodate themselves to the varying forces which the river in its different moods may bring to bear against it, and yet be sufficiently resisting to prevent the deviation of any quantity of water from the desired course, sufficient to impair the depth in the navigable channel.

Under the most favorable conditions, I doubt whether this problem is capable of an entirely satisfactory solution, or that more than temporary results can be secured with anything like a reasonable outlay; but I do think it is possible to adopt a policy of gradual advancement by a series of works that will eventually place the river in such a condition that its navigable features may be greatly improved and maintained with comparatively little further expense. To accomplish this it will first be necessary to remove the snags and impending trees, and then gradually close the chutes and confine the main body of the water to a single channel as far as possible. It is not the intention to effect an entire rectification of the channel by this work, nor that it should comprise all those features which are essentials in the case of a permanent improvement, or that results shall be immediate and conclusive, but rather shall consist of *a following up of the channel little by little, and a holding on to all that can be gained.* The immediate results of such a policy would not be very great, but I feel confident that ultimately it is capable of accomplishing a good deal and will have the advantage of great economy in the beginning, both in the items of working plant and amount of material to be accumulated.

Principal reliance will, therefore, be placed upon a system of light permeable dike construction that may be rapidly placed in position and easily repaired in the event of injury by ice.

DESCRIPTION OF DIKES.

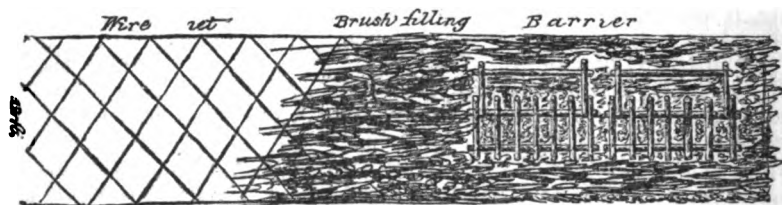
These dikes will necessarily consist of two varieties:

(1.) *Pile dikes*, with iron screws (such as have been used successfully on the Lower Missouri and Mississippi), to be used for closing deep channels, &c.

(2.) *A variety of barrier dike* that may be made in sections and placed in position with almost as little difficulty and almost as great celerity as ordinarily attends the running out of a fishing seine.

Neither of these varieties of dikes are intended to extend much above the low-water surface upon their first application, the height of succeeding applications depending upon circumstances. By persistent application of these means, it is possible in time to successfully close chutes and build up bars that will gain in stability from the growth of willow, cottonwood, and other plants, and eventually bring the channel into such a condition that but little further attention will be required to preserve it.

The wire-screen dikes require no description at my hands. The barrier dikes, on the contrary, are novel, as far as my information extends. They will be constructed as follows:



A wire net will first be made, which will be stuffed with brush, to form a foot mat; the barrier will then be fastened to this, and the whole weighted and sunk in position; the barrier will be about 4 feet high when in position. They may be made in quantities and folded flat until required for use; their form will be readily understood by reference to the sketch. The wire net will be prepared in suitable lengths, and rolled up for use. The operation of unrolling this net, weaving in the brush, attaching the barriers and weights, and sinking, may be readily imagined, and needs no explanation.

ESTIMATES.

A suitable steamer to do the snagging may be purchased for \$15,000, and may be run at an annual expense of \$15,000, making a total for first year \$30,000.

A suitable dredging apparatus for the upper portion of the river may be purchased for \$15,000, and \$50,000 may be profitably expended in labor on the gravelly portion of the river, or for the year a total of \$65,000.

For the sandy portion of the river, which is really about four-fifths of the portion of the river requiring improvement, at least \$300,000 can be profitably expended during the year.

Total sum required for next year, \$395,000.

For further particulars regarding the work in progress, attention is respectfully invited to Captain Maguire's report of last year, also to the reports of Mr. Wood, assistant engineer, which latter are attached.

Money statement.

July 1, 1882, amount available.....	\$1,069 99
Amount appropriated by act passed August 2, 1882	100,000 00
	<hr/> 101,069 99
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$37,919 72
July 1, 1883, outstanding liabilities.....	8,938 35
	<hr/> 46,858 07
July 1, 1883, amount available.....	54,211 92
Amount that can be profitably expended in fiscal year ending June 30, 1885.	<hr/> 395,000 00

REPORTS OF MR. W. H. WOOD, ASSISTANT ENGINEER.

1.

SAINT PAUL, MINN., May 3, 1883.

SIR: I have the honor to make the following report of the work done under my charge on the improvement of the Missouri River, from Sioux City, Iowa, to Fort Benton, Mont., during the present fiscal year:

The United States steamer Emily landed my party of nineteen, all told, at Holmes' Rapids on the 8th of September last. On the 9th we had everything unloaded, buoys set on the upper part of the work (which had been already surveyed by Mr. H. E. Stevens, assistant engineer), and one derrick-boat placed in position. The upper portion of these rapids had been surveyed, and I continued the survey to deep water below the island. The length of channel requiring improvement was about 3,000 feet, and the most of this distance had a depth of less than 4 feet, with a great many bowlders. A portion of it had only 2½ feet of water and was a solid pavement of bowlders. It was much worse than I had expected to find it, and took much longer to do than the time estimated for. Two steam derrick-boats were kept at work here for three weeks, and a full 3-foot channel 100 feet wide was cleared of obstructions. I then moved down to Gallatin Rapids, 5 miles below, leaving my derrick-boat at McKeever's Rapids, about half way between, to do a couple of days' work required here. The water here was of good depth, with a few large bowlders. An iron rod was sunk to a depth of 3 feet, with floats at each end, and run over the rapids. When over it struck a rock, a buoy being thrown overboard from the scow carrying the rod. In this way all the rocks requiring removal were first located, and then the derrick-boat took them out. This boat then joined the other at Gallatin.

This place had been partially worked over by a small party the previous year without a survey, but it was, next after Dauphin's Rapids, the worst place on the river. For about 1,000 feet the river falls at the rate of 8 feet per mile over a solid mass of large bowlders, and is impassable at low water. I took out many large rocks here deeply scored by steamboats pulling over them, besides clearing a hundred-foot channel here. I cleared a triangular space from the landing, an important wood-yard, to the channel. I finished work here on the 24th of October, pulled all the boats up on the high prairie, took an inventory, and placed a watchman in charge and started down the river in small boats to join the steamer Emily, reaching there on November 27.

CUBIC YARDS OF ROCK REMOVED.

Holmes' Rapids	286 yards.....	122 blasts.....	192 inches drilled..
McKeever's Rapids	16 yards.....	2 blasts.....	72 inches drilled..
Gallatin Rapids	465 yards.....	81 blasts.....	44 inches drilled..

Very respectfully, your obedient servant,

W. H. WOOD,
Assistant Engineer.

Capt. JAMES B. QUINN,
Corps of Engineers, U. S. A.

2.

SAINT PAUL, May 14, 1883.

SIR: I have the honor to make the following report of work done by Mr. H. E. Stevens, assistant engineer on the improvement of Missouri River from Sioux City, Iowa, to Fort Benton, Mont., during the season of 1882, compiled from his letters and reports to Captain Maguire. He arrived with the steamer Emily at Gallatin Rapids, when the fleet had been pulled out on May 21. The high water and strong winds havin

1372 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

delayed him a good deal, the trip from Bismarck taking sixteen days. Repairing and launching boats, and making a large rake out of stone grabs fastened to a steel bar.

On the 25th took the Emily to Pablois Rapids and began raking the bar; raked over a space 1,000 feet long and 100 to 200 feet wide; then went to Kipp's Rapids and did the same, returning to Gallatin on June 4.

On June 6 run the first loaded barges from Gallatin to Dauphin's, unloading the rock at shore end of dam, ready to put in when the water fell enough. On June 12 completed the delivery of 270 cubic yards. June 13, delivered 300 yards at McGarry's Dam. June 16, delivered 325 yards at Snake Point Dam, and commenced loading for Grand Island Dam. June 19, delivered 235 yards at foot of Grand Island. June 23, Mr. Stevens went to Benton to telegraph Captain Maguire about rations. Leaving the steamboat hauling rock to Grand Island, he returned on June 30, and there had been delivered while he was gone 310 yards at foot of Grand Island and 98 yards on point above. On June 30 commenced putting material in Grand Island Chute Dam. Water fallen to 3.7 feet. July 17, completed the repairs of this dam, having put in—

Cubic yards rock	506
Fascines	713
Poles	167

One hundred and ten stakes more to be put in when the water falls.

Also dam at foot of Grand Island:

Cubic yards rock	175
Fascines	125
Stakes	280

Also dam at Hammond Island Chute:

Cubic yards rock	210
Fascines	104
Poles	24
Stakes	60

Also put dam above Grand Island shore protection:

Fascines	81
Stakes	200

There were left on the shore line 140 yards of rock to be put on dams at Hammond Island and foot of Grand Island. Stage of river, 2.0, the best stage for repairing Dauphin's, McGarry's, and Snake Point dams. Moved to Dauphin on July 18 and began the repairs there, and on the 20th received a telegram ordering work stopped on account of delay in passing river and harbor bill. On the 21st he took the Emily and all hands to Claggett, and then went by pony to Coal Banks to await further orders.

August 7, resumed work. On 7th and 8th, put 158 cubic yards on Dauphin Dam.

August 9 and 10, put 275 yards on McGarry's Dam.

August 11, put 310 yards on Snake Point Dam.

August 12 and 14, put 248 yards on Cow Island Upper Dam.

August 15 and 16, put 190 yards on Cow Island Middle Dam.

August 17 to 21, put in Grand Island Lower Point Dam 284 fascines, 102 yards rock.

August 22 to 31, put in Hammond Island Point Dam 379 fascines, 387 yards rock.

In September the following work was done here and at Two Calf Island, just below Grand Island:

Locality.	Fascines.	Rock.	Gravel.	Stakes.	Poles.
		<i>Yards.</i>	<i>Yards.</i>		
In Grand Island Lower Point Dam	125	40	128		
In Hammond Island Lower Point Dam ..	27	20	30		
In Hammond Island Chute Dam		124	192		
In Two Calf Island Dam	372	125	270	760	16

On September 12 went to Ryan's Island with the first load of stone and left a large party there to make fascines, the steamboat returning to Annell's Island for more rock. The balance of the season was put in on this Ryan's Island Dam, the largest on the work. October 27, this dam was finished, containing 2,796 fascines, 419 yards rock, 2,385 yards gravel, 5,845 stakes, 437 poles.

On the 28th October started for Saint Paul.

Very respectfully, your obedient servant,

W. H. WOOD,
Assistant Engineer.

Capt. JAMES B. QUINN,
Corps of Engineers, U. S. A.

V 4.

IMPROVEMENT OF THE YELLOWSTONE RIVER, MONTANA AND DAKOTA.

The charge of improving the Yellowstone River was transferred to me the 15th of April last by Captain Maguire, Corps of Engineers. Whatever work has been done upon this river during the past season has been under his supervision.

The work of the past year was confined to the vicinity of Glendive, Mont., and consisted in building several dams, to close chutes and confine the water to the main channel. The location of these dams is clearly given in the accompanying chart.

It is believed that a good deal of scour has taken place in the improved channel, causing a material deepening of the water upon these hitherto difficult shoals.

Quite a number of similar shoals obstruct the course of the river below Glendive, the removal of which would greatly improve the navigation of this river. At present the navigation is so uncertain that but two steamboats ascended the river last year. It is believed, however, with an improved channel the commerce of the river would greatly increase, since it would give a short down-river haul to Fort Buford and vicinity, instead of the 300 miles of up-stream haul upon a difficult river, as at present. In such case freights would be brought to Glendive by railroad, for shipment to Buford.

The plan of improvement at present followed, supplemented by dredging at shoal places, will produce as good results as any other plan.

Since no survey of the lower half of the river has yet been made, it is impossible to estimate the cost of the complete improvement, but it is believed that \$100,000 can be profitably expended during the ensuing year in extending the present work down the river.

The lack of funds has limited the present season's work to the care and preservation of existing dams, and the making of a reconnaissance of the unimproved portion of the river.

Detailed information of the work accomplished last year will be found in the accompanying report of Mr. Towar, assistant engineer.

Money statement.

July 1, 1882, amount available.....	\$2, 115 99
Amount appropriated by act passed August 2, 1882.....	20, 000 00
	<hr/>
	22, 115 99
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$16, 886 42
July 1, 1883, outstanding liabilities.....	399 94
	<hr/>
	17, 286 36
July 1, 1883, amount available.....	4, 829 63
	<hr/>
Amount that can be profitably expended in fiscal year ending June 30, 1885.	100, 000 00

REPORT OF MR. F. M. TOWAR, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Saint Paul, Minn., April 25, 1883.

SIR: I have the honor to submit the following report of improvements made on the Yellowstone River during the fiscal year ending June 30, 1883:

On account of the late passage of the appropriation bill, work was not commenced on the Yellowstone River until August.

The force on the work was composed of two parties, consisting, each, of one assistant engineer, one recorder, an overseer, and twenty-three men.

The parties left Saint Paul August 11, 1882, and arrived at Glendive, Mont., 13. Here the party, under Assistant Engineer Durance, stopped and proceeded to the river to the place of storage of camp equipage, boats, and working supplies during the previous season. He at once commenced getting ready for active operations. The party under myself proceeded to Baker Rapids to get ready the stored at that place.

The party arrived at the latter place on August 14, and commenced work.

The boats were repaired, calked, and launched, and on August 24 I left Baker Rapids and proceeded to the place of operations, at Glendive, arriving there in the afternoon of August 25. Mr. Durance's party had arrived two days previous were already engaged in collecting material for the proposed work.

The work proposed was the improvement of Glendive Shoals, which extend a distance of about 4 miles of river, commencing at the village of Glendive and ending about one-half mile below the old cantonment.

The Yellowstone River, at Glendive, divides into two channels, forming an island about 2 miles long, with about an equal amount of water flowing in each, in one of which is there a sufficient depth for low-water navigation, each having a width with about 2½ feet of water over it. After examination, it was determined to close the left-hand channel by diking it, and thus forcing all the water into the other channel.

Work on this dike was commenced late in the fall of 1881, but it was not completed on account of the formation of an ice gorge above and upon it, rendering the surface ballasting and other strengthening of it impossible.

The construction of this dike, although incomplete, has had the effect of turning a greater part of the water into the other channel, and causing the diked channel to fill in, both above and below the dike. The additional work of strengthening the dike extending this dike was done last season, giving it a length of 710 feet, with a base of 50 feet, and a height above low water of 1.5 feet.

Beside the completion of the last-mentioned work, four other dikes have been constructed in the improvement of the Glendive Shoals; the next of these in order about a mile below this one, or about half way between the head and foot of the island, where the river divides itself into three channels, the left hand one carrying about one half of the discharge, the remainder being divided about equally between the other two. It was decided to close the largest of these, viz: the left hand one, and force all the water through the others, assuming that the narrow gravel bars separating these channels would scour out and make one good channel, from 400 to 500 feet in width, having a high rocky shore on one side, and a compact gravel bar on the other.

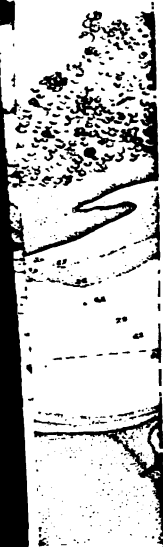
The dike put in here was 516 feet long, with a base of 40 feet and a height of 5 feet above low water. About a mile below the above-described work we find the whole river united again in one channel, continuing so, however, for about a half mile, when the water again separates into three channels. The left and middle channels discharge nearly all the water, only a very small portion passing through the right-hand channel. After a thorough examination, it was decided to close the middle channel and throw all the water through the middle one. The reasons for choosing this were that the left-hand channel had soft and unstable banks and three ledges of rock that would be difficult to remove. The right-hand channel was small, narrow, and not navigable. The middle channel has a least depth of 4.5 feet at low water, and its only obstruction is a soft gravel bar at its foot, which commenced to scour and move down after the side channels had been closed. The dike closing the left channel is 950 feet long, has a base of 40 feet, and is also carried 1.5 feet above low water. The right channel was closed by a dike 203 feet long, a base of 50 feet and a height of 9 feet.

A small stream of water branches off about midway between the head and foot of the middle channel, and as the probabilities were that some of the increased volume of water would force itself through this place, and cause a scour that might materially increase its volume, and thus divide the discharge of the river, it was decided to close it; a dike was therefore constructed 516 feet long, with a base of 38 feet, and a height of 4 feet. This was the last of the larger works. A number of small protections for low places on the shore, at which a scour might possibly occur, were made.

The method of construction of these dikes was the same as that followed in the construction of those built in 1881, of which detailed plans and drawings were then made.

Fascines were made of cotton wood, or willow, about 10 inches thick, and from 25 feet long, tied with tarred rope, and placed either singly or in mats; a layer of these fascines was run across the river on the site of the proposed dike and weighted down with rock; on top of these another row of fascines was laid, but with the butts 10 feet higher up-stream, thus forming an apron; this row was also ballasted with rock; the third row of fascines was laid in like manner, except that their butts were only placed 4 feet further up stream than those of the second layer; the fourth, fifth, &c., layers were placed in like manner until the crown of the dike was 1.5 feet above low water. The shore ends of the dike were sunk in trenches and also weighted

f Engineers



down with rock; then the whole dike was covered with gravel from 6 to 8 inches in thickness, making the whole work compact and stopping the leakage.

The result of the construction of these dikes will be that the entire discharge of the river at a stage of 1 foot above low water will flow through one channel, and if there should be no break in any of them, then a stretch of river from Glendive to a point 10 miles below will admit of a draught of 4.5 feet of water.

The following table gives the amount of material placed in the above-described works:

Fascines made and laid.....	6,806
Mats made.....	565
Mat poles made.....	3,390
Stakes driven.....	4,268
Cubic yards of rock placed.....	2,003
Cubic yards of gravel placed.....	2,533
Piles driven.....	15

The work at Edgerly Island Shoals during the season of 1881 fully proved that when the whole volume of water in this river was made to discharge itself through one channel, by closing the lateral chutes, that a good channel was obtained, and apparently a permanent one.

The small amount of commerce on the Yellowstone River last season was due to the completion of the Northern Pacific Railway to the head of navigation on the river. The arrival of two steamers from Bismarck at Glendive with 600 tons of freight, however, had the effect of reducing the railway freights one-fourth, which reduction continued in force until the end of the season of navigation, when freights were advanced to the old rates.

Improvements are needed at about ten places between Glendive and Diamond Island; the latter point is as far as the survey has reached, and consequently I cannot accurately state the amount of work necessary to improve the river between Diamond Island and its mouth, but I think that about an equal number of bad places exist in that stretch of river, as between Glendive and the last-named point.

Now that the Glendive Shoals have been improved, the next most important place is Stanley's Shoals, 55 miles below, where there is fully as much work as at Glendive.

The parties were withdrawn from the field on November 15, and discharged.

Since November 15 I have been engaged in making maps and drawings showing progress of the work, and making plans and estimates for the coming season, reducing gauge readings, and computing and reducing gauging notes to determine the discharge of the river at various stages.

Very respectfully, your obedient servant,

F. M. TOWAR,
Assistant Engineer.

Capt. JAMES B. QUINN,
Corps of Engineers, U. S. A.

APPENDIX W.

IMPROVEMENT OF THE NAVIGATION OF THE MISSISSIPPI RIVER BETWEEN SAINT PAUL AND THE MOUTH OF THE ILLINOIS, INCLUDING IMPROVEMENTS AT SPECIAL LOCALITIES BETWEEN THOSE POINTS—IMPROVEMENT OF CUIVRE RIVER, MISSOURI—OPERATING AND CARE OF DES MOINES RAPIDS CANAL.

REPORT OF MAJOR ALEXANDER MACKENZIE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|---|--|
| 1. Upper Mississippi River, operations of snag-boat, &c. | 10. Mississippi River at Andalusia, Ill. |
| 2. Mississippi River from Saint Paul to the Des Moines Rapids. | 11. Harbor at Muscatine, Iowa. |
| 3. Mississippi River from Des Moines Rapids to mouth of Illinois River. | 12. Harbor at Fort Madison, Iowa. |
| 4. Harbors of refuge on Lake Pepin. | 13. Des Moines Rapids, Mississippi River. |
| 5. Mississippi River at Guttenberg, Iowa. | 14. Operating and care of Des Moines Rapids Canal. |
| 6. Removal of bar in Mississippi River opposite Dubuque, Iowa. | 15. Dry dock at the Des Moines Rapids Canal. |
| 7. Ice harbor at Dubuque, Iowa. | 16. Mississippi River near Alexandria, Mo. |
| 8. Rock Island Rapids, Mississippi River. | 17. Mississippi River at Quincy, Ill. |
| 9. Harbor at Rock Island, Ill. | 18. Quincy Bay, Illinois. |
| | 19. Mississippi River at Hannibal, Mo. |
| | 20. Mississippi River at Louisiana, Mo. |
| | 21. Cuivre River, Missouri. |

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 16, 1883.

GENERAL: I have the honor to transmit herewith the annual reports of operations under my charge during the fiscal year ending June 30, 1883.

Very respectfully, your obedient servant,

A. MACKENZIE,
Major of Engineers,

The CHIEF OF ENGINEERS, U. S. A.

W 1.

OPERATIONS OF SNAG-BOAT IN IMPROVEMENT OF UPPER MISSISSIPPI RIVER.

Under this appropriation are operated the snag-boats, whose duties consist of removing snags, wrecks, and other obstructions from the channel of the Upper Mississippi; cutting trees and clearing banks; towing boats and barges and rendering assistance to fleets engaged in

work of improvement; inspecting and repairing works already constructed; sounding, establishing, and marking new channels; assisting stranded boats and barges, and, in general, facilitating navigation and rendering assistance both to the parties engaged in permanently improving the river and to those navigating it.

The cutting and pulling back of large trees found close to the bank, and the comparatively slow rate at which the banks cut on the Upper Mississippi and its tributaries, result in but a small number of snags finding their way into the channel. The channel of the river being though, at times of low water, comparatively narrow and close, often renders the removal of even a single snag of the greatest importance; for there are many places on the upper section of this district where a single tree falling across, or snag getting in the channel would entirely suspend navigation.

There are numerous wrecks in the Upper Mississippi, and the changeable channel of the river is frequently brought so close to them as to render navigation dangerous. The removal of these wrecks is gradually being accomplished.

Since the services of snag-boats have been available on the Upper Mississippi, the damages to boats from sunken obstructions have become very rare, while formerly the sinking of steamers was quite common. In nearly every case where accidents now occur they arise from unknown obstructions, which cause no ripple on the water, and whose existence cannot therefore be known in advance; but many of such obstructions are removed annually, and the general safety of navigation is being constantly increased.

From the above summary the importance of the work of the snag-boat can be estimated, and from the nature of the work the necessity for the patrolling of the river is apparent.

The work of the past season is fully given in the appended report of Assistant C. W. Durham, who, as in previous years, has superintended the operations of the snag-boat with such zeal and efficiency as not only to secure good work, but also to furnish a large amount of information of the greatest value in connection with the permanent improvement of the river.

During the fiscal year ending June 30, 1883, the snag-boat Barnard has performed her usual duties.

The new light-draught snag-boat J. G. Parke was completed in July, 1882, and used during latter part of same year as a tow-boat in connection with river improvement.

The failure of the last river and harbor bill will not permit carrying out as much of the regular work of these snag-boats as is desirable, but they will be made serviceable in connection with the building of dams and shore protections, which work can be carried on under other appropriations.

My report on the Upper Mississippi River has heretofore referred to certain matters of great importance to the interests of navigation.

I would again refer to the necessity of facilitating navigation through the many bridges now crossing the river. Some action should be taken which will either compel bridge companies to do such work as is necessary, or the United States should itself carry out the work. It seems useless to continue other general improvement of the river and leave undone the work which, of all others, is of the first importance.

During the past year the Mississippi River has been at a good boat-ing stage, and the largest class of boats were able to reach Saint Paul,

excepting during about two days, when a bar within sight of Saint Paul levee caused some detention.

It is hoped the full amount asked for the next fiscal year will be granted, as it cannot be materially reduced without affecting the efficiency of the service performed under this head of appropriation.

ABSTRACT OF APPROPRIATIONS.

By act approved March 2, 1867	\$96,000
By allotment from appropriation of July 25, 1868	26,000
By allotment from appropriation of 1869	35,640
By act approved July 11, 1870	36,000
By act approved March 3, 1871	42,000
By act approved June 10, 1872	42,000
By act approved March 3, 1873	25,000
By act approved June 23, 1874	25,000
By act approved March 3, 1875	25,000
By act approved August 14, 1876	30,000
By act approved June 18, 1878	41,500
By act approved March 3, 1879	20,000
By act approved June 14, 1880	8,000
By act approved March 3, 1881	25,000
By act passed August 2, 1882	25,000
	<hr/>
	502,140

Money statement.

July 1, 1882, amount available	\$1,374 94
Amount appropriated by act passed August 2, 1882	25,000 00
	<hr/>
	26,374 94
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	16,187 08
	<hr/>
July 1, 1883, amount available	10,187 86
	<hr/>
Amount that can be profitably expended in fiscal year ending June 30, 1885.	30,000 00

REPORT OF C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 2, 1883.

MAJOR: I have the honor to present my annual report on improving Upper Mississippi River for the fiscal year ending June 30, 1883, together with some statistics of commerce and navigation.

OPERATIONS OF SNAG-BOAT GENERAL BARNARD.

In June and July, 1882, the *General Barnard* was thoroughly repaired and repainted and put in readiness for service.

On August 22 she left Dubuque for Saint Paul with two barges and steam launch Mary in tow for use in improvements in vicinity of Saint Paul, where she arrived August 26.

From August 28 to September 9 she was employed between Saint Paul and Rock Island removing snags, impending trees, wrecks, &c.; establishing water-gauges, buoys, and channel marks, and rendering occasional service to the works of permanent improvement.

On this trip obstructions were removed at or near Frenchman's Bar, Pig's Eye, Kaposia, Red Rock, Newport, Merrimac, Robinson's, Nininger, Prescott, Eagle Bluff, Diamond Bluff, Trenton, Crat's Island, Beef Slough, Rollingstone, Betsy Slough, Trempealeau, Richmond, Root River, Coon Slough, Bad Axe, Lansing, Glen Haven, Maquoketa Slough, and Dark Slough.

On September 10 she worked on head of island at Hershey Boom.

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September 11 she took two barges in tow and started down river, dropped barges at Dixon's Landing, and arrived at Saint Louis September 15.

From September 16 to October 4 she worked between Saint Louis and Dubuque, removing snags, &c., at Wilson's Bend, Piasa, Iowa Island, Enterprise, Milan, Golden Eagle Chute, Cap au Gris, Sandy Island, Turner's, Sterling, Falmouth, Clarksville, Cincinnati Landing, La Grange, Montrose, Keithsburg, and New Boston.

During remainder of season of 1882 the *Barnard* was used in connection with the snag-boat J. G. Parke, and a quarter boat for housing and subsisting men employed in construction work at Guttenberg, Cassville Slough, and Fort Madison. She also assisted in towing fleet from Guttenberg to Fort Madison, and from Fort Madison to Keokuk. Laid up in winter quarters November 16.

In 1883 the *Barnard*, having been put in condition for service, raised steam on 2d of May, and from that time until June 29 was employed between Saint Louis and Saint Paul at her usual duties.

On account of prevailing high water her snagging work was not as effective as heretofore.

A part of her work consisted in towing two barges from Cap au Gris to Quincy, six dump-scows from Rock Island to Keokuk, and a fleet of sixteen barges and steamboat Fury from Wabasha to Nininger.

She laid up in canal at Keokuk June 30.

Summary of operations of United States steamer General Barnard for fiscal year ending June 30, 1883.

Items.	Season of 1882.	Season of 1883.	Total for fiscal year.
Snags removed.....	143	52	195
Leaning trees pulled back.....	67	23	90
Leaning trees felled.....	728	164	892
Wrecks destroyed.....	3	.....	3
Soundings recorded.....	296	.....	296
Boulders removed.....	1	.....	1
Gauges established.....	2	.....	2
Miles run.....	2, 024	1, 897	3, 921

OPERATIONS OF SNAG-BOAT J. G. PARKE.

This stern-wheel boat was built under the appropriation of March 3, 1881, by Howard & Co., of Jeffersonville, Ind. She is of wood, and her principal dimensions are as follows: Length on deck, 140 feet; beam, 28 feet; hold, 4 feet; two non-condensing engines, with cylinders 14½ inches diameter by 6 feet stroke; three Otis steel boilers, 40-inch shell, 20 feet long, with five 9-inch return flues in each.

Her cost completely furnished and outfitted was \$22,000; she has proved a very serviceable boat, and of excellent speed.

Her trial trip was made July 27, 1882, and on the 29th she left Jeffersonville for the Upper Mississippi River with three barges in tow. She was employed from that time until August 20 in towing from the Ohio River to Keokuk and Davenport barges loaded with oak lumber and coal for Government use; on the latter date she was laid up temporarily at Eagle Point, above Dubuque.

On October 5 the *Parke* was again brought out for purpose of building dams and shore protections, and was kept at this work until November 16, when she was laid up in the canal at Keokuk. During this time she was employed in the construction of 3,300 feet of shore protection near Guttenberg, in Cassville Slough, and opposite Fort Madison.

Total mileage for season, 1,976.

She still remains laid up at Keokuk, but will soon be brought out for construction work near Hannibal, Mo.

RIVER NOTES.

The river in 1882 was at a good navigable stage nearly the entire season, and there being no low-water periods when the *Barnard* and *Parke* were in commission, but few soundings were taken. In fact (a couple of days excepted) all boats could reach Saint Paul throughout the year.

In 1883 the river has remained at a high stage up to time of present writing.

STATISTICS OF COMMERCE AND NAVIGATION.

Lumber.—The most important business interest on the Upper Mississippi River and its principal tributaries is the lumber trade, which gives employment to great numbers of men and upwards of one hundred steamboats which are used in guiding and propelling rafts.

Between the mouth of the Chippewa and Saint Louis there are eighty mills on the main river with an annual day sawing capacity of 800,000,000 feet, employing some 16,000 men, and representing about \$16,000,000 capital.

On the Upper Mississippi and its tributaries, the Saint Croix, Chippewa, Wisconsin, and Black, there are about two hundred mills engaged in the manufacture of lumber, the greater part of which product is floated into the former stream.

Steamboats and freight.—The principal steamboat lines on the Upper Mississippi River are the Saint Louis and Saint Paul Packet Company, and the Diamond Jo Line. There are also independent boats carrying freight and passengers. The total amount of freight carried by these two lines was in 1882, 310,795 tons; in 1881, 380,000 tons; in 1880, 567,180 tons; in 1879, 411,862 tons. Passengers carried by above lines in 1882, 47,606.

Statement of amount of freight received and shipped from Saint Louis by the Upper Mississippi River for five years.

	1882.	1881.	1880.	1879.	1878.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Received	135,540	190,815	228,095	221,285	174,065
Shipped	71,325	54,295	55,260	66,990	67,320
Total carried	206,865	245,110	281,855	288,275	241,385

Movement in flour and grain by Upper Mississippi boats in 1882.

Saint Louis.	Flour.	Wheat.	Corn.	Oats.	Rye.	Barley.
	<i>Barrels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Receipts	79,828	398,498	372,560	1,114,178	20,740	238,762
Shipments	18,346	43,852	9,615	13,149	1,159	3,285
Total movement	98,174	442,350	382,175	1,127,327	21,899	242,047

The following table affords a comparative view of the relative amount of navigation at various localities on the Upper Mississippi River for the last three years:

Locality of bridge.	Steamboats.			Barges.			Rafts.		
	1882.	1881.	1880.	1882.	1881.	1880.	1882.	1881.	1880.
Hastings	2,563	1,843	2,065	710	563	448	60	14	29
Winona	5,627	4,739	4,593	942	575	883	1,939	1,777	1,392
La Crosse	4,728	4,461	3,539	576	448	505	1,707	1,608	1,278
Dubuque	4,345	4,710	3,625	822	666	878	1,022	1,380	1,375
Sabula	2,584	2,317		317	853		(?)	958	
Clinton	3,185	3,167	3,253	670	721	1,020	487	\$370	\$646
Rock Island	2,593	2,711	2,604	293	449	642	984	953	782
Burlington	2,323	2,312	1,871	466	663	694	425	523	522
Keokuk	2,034	2,746	1,868	814	1,922	890	444	(?)	(?)
Quincy	2,087	1,895	1,831	654	591	616	391	396	349
Hannibal	3,031	1,909	1,925	578	686	760	300	822	237
Louisiana	1,249	1,195	1,459	472	628	705	111	114	110

* Ferry-boat 845 times.

† Built in 1880.

‡ No record of rafts.

§ Partial record.

CUSTOMS REVENUE AND TONNAGE FOR YEAR ENDING DECEMBER 31, 1882.

That portion of the Mississippi River between Saint Paul and the mouth of the Illinois River lies partly in the customs district of Minnesota and partly in the district of New Orleans. Surveyors of customs are located at Burlington and Dubuque, Iowa; Galena, Ill.; Saint Paul, Minn.; and La Crosse, Wis.

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In the following statement is given the total exhibit of the port of Saint Louis where the greater part of the Upper Mississippi boats are registered, and which includes many of the Lower Mississippi, Missouri, and Illinois river boats :

Port.	Collections.	Enrolled tonnage.	Vessels.
Saint Louis.....	\$1,319,038 49	180,712	309
Burlington.....	None	4,466	39
Dubuque.....	2,255 51	4,091	25
La Crosse.....	2,267 43	5,863	42
Galena.....	None	2,570	21
Saint Paul.....	45,107 69	3,579	36

INTERNAL REVENUE.

There are ten internal-revenue districts bordering on the Mississippi River between Saint Paul and the mouth of the Illinois River. Each of these districts is composed of a large number of counties, the greater portion of which do not touch the river, but the bulk of the revenue to the government comes from the sections bordering on the river and tributary to its navigation and commerce. I give below a table showing the designation of the districts touching on the river between the points above named, the residence of the collector, and the amount of collections for year ending December 31, 1882.

Districts.	Residence of collector.	Amount collected for the year ending December 31, 1882.
First Minnesota.....	Albert Lea.....	\$130,183 34
Second Minnesota.....	Saint Paul.....	435,385 72
Second Wisconsin.....	Madison.....	205,870 64
Sixth Wisconsin.....	Sparta.....	183,933 91
Second Iowa.....	Davenport.....	445,079 03
Third Iowa.....	Dubuque.....	323,787 45
Fourth Iowa.....	Burlington.....	174,754 70
Third Illinois.....	Sterling.....	437,585 14
Fourth Illinois.....	Quincy.....	914,059 40
Fourth Missouri.....	Louisiana.....	467,666 28
Aggregate.....		3,715,305 61

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

W 2.

IMPROVEMENT OF THE MISSISSIPPI RIVER FROM SAINT PAUL TO DES MOINES RAPIDS.

During the past fiscal year, as in former seasons, works carried on under this appropriation have been for the improvement of through navigation.

The limited amount of appropriations, as compared with the long stretch of river requiring improvement, and a desire to benefit those at present engaged in navigation as well as future generations, have led to a system of selecting those points for work which, for the time being, were the greatest obstructions, care being taken to adapt such work to the general plans adopted for the formation of a permanent channel throughout the entire length of the Upper Mississippi from the mouth of the Illinois River to Saint Paul.

The works of improvement being carried out consist in the construction of brush and stone, closing, and wing dams and shore protections.

The river is gradually being brought into one channel; wide places are being contracted so as to give the river a uniform width of such dimensions as to secure a sufficient depth; caving banks and the heads of islands are being protected.

The dams constructed for reducing the width are as far as practicable so located as to continually throw the channel into the concave bends against a bank, the shore being protected so as to prevent abrasion.

Owing to the difficulty of selecting points for improvement sufficiently long in advance for making definite plans and specifications, and again there being only a few contractors able and willing to undertake work at reasonable prices, it has been found necessary to carry on much of the work by day's labor and open purchase. This has led to the accumulation of a large and efficient fleet of tow-boats, barges, &c., and by means of this plant the Government now finds itself able to carry on work more promptly and efficiently than ever before.

The possession of this plant does not indicate that contract work has been abandoned, and in the future, as heretofore, as many contracts will be recommended as the circumstances permit. This is necessary if much work is to be accomplished, as, owing to the comparatively short season during which work can be carried on, it is necessary to operate simultaneously at more points than if the working season were longer, and more than can be provided for even by the large fleet of Government boats and barges available.

During the past year work has been carried on by day's labor from Saint Paul to Hastings, from Wabasha to Alma, at Cassville Slough and Guttenberg, Rush Chute and Shokokon Slough, Fort Madison, and Montrose; and by contract from Homer to Queen's Bluff, from Mount Vernon to Fountain City, and from La Crosse to Brownsville.

Surveys have been made at various localities to furnish data for laying out new work, and numerous examinations have been made to determine condition of channels.

It was hoped the stage of river would be such at some time during the year as to permit a comparison of the present low-water condition of certain improved points with their former condition, but no opportunity has offered for such examinations as could be satisfactorily prepared for publication.

The coming months promise a very low-water season, when detailed examinations will be made, and it is believed maps can be prepared which will show graphically the very beneficial results which have been accomplished. If the formation of a permanent and sufficiently deep channel in the Upper Mississippi is of such great importance to the interests of commerce as is claimed, and if the improvement has been fully determined on, it would be to the great advantage of the work to have the annual appropriations increased so that good may sooner result and greater economy be secured by more systematic methods of working. At present it is only permissible to apportion a comparatively small amount to each of a large number of points, and the cost of preparing for work and of moving fleets from point to point so often is proportionately much greater than it would be with more liberal appropriations, which would allow the allotment of a large amount of money to each separate work. An appropriation to cover several years' work would be still better, as this would permit a perfect system of collecting material, securing proper supervision, and carrying on efficient work at the least practicable cost.

The work of improvement and survey carried on during the past year is given in appended reports. It has been carried on under the immediate supervision of Assistants Hoffman, Gillespie, and Marr, and to these gentlemen much credit is due for prosecuting their work with vigor and prudence.

The act of Congress of March 3, 1879, allotted \$20,000 for the trial of the "Adams Flume," under the supervision of the inventor, and the act of August 2, 1882, contained an additional appropriation of \$8,000 for this work.

During the past four years Mr. Adams has been preparing for his experiments, but as yet his pipe has not been laid in the river. I understand he is prepared, and expects, if his funds permit, to test his invention during the coming season of low water.

The work of the coming fiscal year will consist principally in the completion of work heretofore commenced. The comparatively small amount of money available for expenditure will not justify the commencement of much new work. This is to be regretted, as such partial suspension of work causes the disbandment of crews of trained men, breaks up the parties engaged in getting out material, and causes considerable extra expense in connection with the care of Government fleets.

The last river and harbor act provided that of the \$250,000 appropriated for "Improvement of Mississippi River from Saint Paul to Des Moines Rapids," \$15,000 should be expended for improving the banks and channel of the river at West Saint Paul. It is not understood what work is to be accomplished with this money, and its expenditure has not yet been recommended.

No further experiments in willow planting have been made during the past year in consequence of the high stage at which the river has remained nearly all the time. This constant high water which has covered all the bars has also had the effect of killing all the trees heretofore set out. The establishment of willow plantations on the upper section of the Mississippi appears to be a difficult matter to accomplish, but it will continue to receive attention, as will also the use of temporary obstructions for the purpose of building up sand-bars, and increasing the rate of filling between the wing-dams.

I give below a brief summary of operations carried on during last fiscal year between Saint Paul and Des Moines Rapids.

SAINT PAUL TO HASTINGS.

Work in this section of river was done by hired labor and open purchase, United States tow-boat No. 1, steam-launch No. 1, and barges being employed in transporting material and putting it in place.

There were constructed during fiscal year 8,814 linear feet of dams and 15,160 linear feet of shore protections, containing 24,658 cubic yards of rock and 34,053 cubic yards of brush, at a cost, including superintendence and office expenses, of \$57,846.15, an average of 99 cents per cubic yard for material in place.

At a $4\frac{1}{2}$ -foot stage the river between Saint Paul and Hastings is now in one channel, the side sloughs having all been closed by dams with crests at a minimum height of $4\frac{1}{2}$ feet above low water. A great many wing and spur dams have also been built for narrowing the wider portions of the river, but a good deal of this kind of work still remains to be done.

WABASHA TO ALMA.

Work in this section was conducted in a similar manner to that above mentioned, tow-boat No. 2 and steam-launch No. 2 being used for towing.

There were constructed during the year 10,812 linear feet of dams and 4,317 feet of shoal protecting, containing 18,467 cubic yards of rock and 10,904 cubic yards of brush, at a cost, including superintendence and office expenses, of \$33,580.33, an average of \$1.14 per cubic yard for material in place.

AT GUTTENBERG, IOWA.

A small amount of money was allotted for work at this point. A description of this work is given under the head of "Mississippi River at Guttenberg, Iowa."

AT FORT MADISON, IOWA.

Work at this point is reported under head of "Harbor at Fort Madison." A small allotment was made from the general appropriation for use in protecting the bank opposite the town.

MOUNT VERNON TO FOUNTAIN CITY.

An allotment of \$20,000 was made for work in this locality. Proposals for building brush and stone dams and shore protections were called for and the contract was let October 6, 1882, to Jacob Richtman, of Fountain City, the lowest bidder. His contract was completed June 9, 1883.

SUMMARY OF WORK.

7,954.46 cubic yards rock, at \$1.45	\$11,533 97
6,442.70 cubic yards brush, at 95 cents	6,120 56
Superintendence and office	746 52
Total	18,401 05

An average cost of \$1.28 per cubic yard.

LA CROSSE TO BROWNSVILLE.

An allotment of \$25,000 was made for this work. Contract was awarded to P. S. Davidson, of La Crosse, Wis., the lowest bidder.

He began operations October 7, 1882, and completed his contract June 2, 1883.

SUMMARY OF WORK.

9,367.36 cubic yards rock, at \$1.25	\$11,709 20
6,102.79 cubic yards brush, at 85 cents	5,187 37
Superintendence and office	1,038 93
Total	17,935 50

An average cost of \$1.16 per cubic yard.

HOMER TO QUEEN'S BLUFF.

An allotment of \$25,000 was made for this work. The contract was awarded to P. S. Davidson, the lowest bidder.

He began operations June, 1883, and is now going on with the work.

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SUMMARY OF WORK.

1,966.80 cubic yards rock, at \$1.35.....	\$2,655 18
1,895.60 cubic yards brush, at 95 cents.....	1,800 00
Superintendence and office.....	70 10
	<hr/>
	\$4,526 10

Part of the work is still unpaid for.
Average cost per cubic yard, \$1 17.

CASSVILLE SLOUGH.

Shore protection on the head of the small island in Devil's Elbow was begun October 25, 1882, by the snag-boat J. G. Parke and a fleet of seven barges, and was completed October 28.

This work was done for the purpose of preserving the tow-head and thereby preventing too great enlargement of the water-way at that point, and also as preparatory to the construction of a dam across the elbow, one end of which is to abut on the tow-head. The length of shore protected was 420 feet.

Material put in work:

Rock, 365.4 cubic yards.
Brush, 343 cubic yards.

MATERIAL.

There are collected in vicinity of Glen Haven, Wis., and Cassville Slough about 3,000 cubic yards of rock, and at Nauvoo, Ill., about 5,000 cubic yards.

RUSH CHUTE AND SHOKOKON SLOUGH.

Work at this locality was done by hired labor and purchase in open market, the towing being performed by United States tow-boat No. 3 and steam-launch No. 3.

There were 12,524 cubic yards of rock and 2,489 cubic yards of brush put in the work. The expenditure during the year, including superintendence and office expenses, was \$18,622.28. To this must be added \$3,113.64, the value of material on hand and paid for prior to July 1, 1882, making a total of \$21,736.32, or an average cost of \$1.44 per cubic yard for material in place.

The average cost per yard of material in this work was much increased by the difficulties of construction and the necessity of using so large a proportion of rock, the more expensive material.

MONTROSE.

This work was also carried on by hired labor and open purchase of material. United States tow-boat No. 4 was employed in transporting and putting in material.

There were put in the work 3,337.68 cubic yards rock and 2,650.10 cubic yards of brush. The expenditure during the year was \$5,793.02, to which must be added \$978.58, value of material on hand prior to July 1, 1882, making a total of \$6,771.60. Average cost per yard, \$1.10.

PLANT.

A number of stone-barges were built by Jos. Reynolds at Dubuque, and by Eckhardt & Son at Davenport, Iowa. A part of these were used in 1882 between Wabasha and Alma, and the remainder at Burlington.

An experimental "feathering" wheel was placed on tow-boat No. 3,

but after being some time in service the shaft was broken, it being too light for the purpose. In the spring of 1883 some modifications were made in the wheel, and it worked quite satisfactorily and made considerable saving in fuel; yet still further changes are necessary before its superiority to the ordinary radial wheel can be demonstrated.

SUMMARY OF EXPENDITURES FOR FISCAL YEAR ENDING JUNE 30, 1883.

Saint Paul to Hastings	\$57,846 15
Wabasha to Alma	33,580 33
Mount Vernon to Fountain City	18,812 38
Homer to Queen's Bluff	3,206 82
La Crosse to Brownsville	17,935 50
Guttenberg	448 07
Cassville Slough	1,780 19
Rush Chute and Shokokon Slough	18,622 68
Montrose	5,793 02
Plant	19,590 70
Fort Madison	2,139 24
Nauvoo Rock	497 57
Glen Haven Rock	423 75
Surveys and gauges	2,745 63
Total	183,422 03

Of the above amount \$15,500 was reported as outstanding liabilities in last annual report.

ABSTRACT OF APPROPRIATIONS.

By act approved June 18, 1878	\$250,000
By act approved March 3, 1879 *	100,000
By act approved June 14, 1880	150,000
By act approved March 3, 1881	200,000
By act passed August 2, 1882	250,000
	950,000

Money statement.

July 1, 1882, amount available	\$21,339 91
Amount appropriated by act passed August 2, 1882	250,000 00
	271,339 91
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$167,066 61
July 1, 1883, outstanding liabilities	523 34
	167,589 95
July 1, 1883, amount available	103,749 96
Amount that can be profitably expended in fiscal year ending June 30, 1885	1,000,000 00

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, Rock Island, Ill., at 2 p. m., September 23, 1882, for completing dams and shore protections of brush and stone between La Crosse Bridge, Wis., and Brownsville, Minn.

No.	Names and residences of bidders.	Brush.	Stone.	Aggregate
		Per cu. yd.	Per cu. yd.	
1	P. S. Davidson, La Crosse, Wis.,†	\$0 85	\$1 25	\$2 10
2	S. J. & A. H. Truax, Hastings, Minn.	1 10	1 75	2 85
3	D. A. McDonald	92	1 53	2 45

*200,000 set aside for testing "Adams Flume."

† Contract awarded.

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Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, Rock Island, Ill., at 2 p. m., September 23, 1882, for constructing dams and shore protections of brush and stone between Mount Vernon, Minn., and Fountain City, Wis.

No.	Names and residences of bidders.	Brush.	Stone.	Aggregate.
		<i>Per cu. yd.</i>	<i>Per cu. yd.</i>	
1	J. Richtman, Fountain City, Wis.*	\$0 95	\$1 45	\$2 40
2	S. J. & A. H. Truax, Hastings, Minn.	1 10	1 75	2 85

* Contract awarded.

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, Rock Island, Ill., at 2 p. m., September 23, 1882, for constructing dams and shore protection of brush and stone between Homer, Minn., and Queen's Bluff, Minn.

No.	Names and residences of bidders.	Brush.	Stone.	Aggregate.
		<i>Per cu. yd.</i>	<i>Per cu. yd.</i>	
1	S. J. & A. H. Truax, Hastings, Minn.	\$0 98	\$1 45	\$2 44
2	S. D. Van Gorder, Hastings, Minn.	1 40	1 85	3 25
3	P. S. Davidson, La Crosse, Wis.*	95	1 85	2 80

* Contract awarded.

REPORT OF MR. J. L. GILLESPIE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 2, 1883.

MAJOR: I have the honor to submit my annual report on works in my charge for the fiscal year ending June 30, 1883.

BETWEEN SAINT PAUL AND HASTINGS, MINNESOTA.

Operations were carried on by hired labor and purchase of material in open market, the United States tow-boat No. 1, steam launch No. 1, and fleet of barges being used for transporting and putting the material in place. Work was begun June 10, 1882, and continued until November 15, without intermission.

During the month of July the following work on dams and shore protections was accomplished:

- Shore protection on head of Island No. 5, commenced in June, 300 feet in length.
- Dam 5 (sheet 3), 160 feet long, from foot of Island 3 to Island 4.
- Shore protection on head of tow-head above Island No. 3; 80 feet in length.
- Dam 8, (sheet 3), spur from right bank, 2,600 feet above Island 9; length, 670 feet.
- Dam 11 (sheet 2), from left bank to tow-head above Island No. 3, begun in 1881; length, 170 feet.
- Dam 7 (sheet 3), spur from right bank, 3,700 feet above Island 9; length, 530 feet.
- Dam 12 (sheet 2), from left bank to Island No. 2; length, 170 feet.
- Dam 5 (sheet 4), spur from right bank about 1,200 feet above Island No. 9; commenced.
- Dam 6 (sheet 4), spur from right bank nearly opposite Island No. 9, commenced.
- In August the work accomplished was as follows:
- Dam 5 (sheet 4), spur from right bank commenced in July; length, 800 feet.
- Shore protection on left bank, opposite Dam 8 (sheet 3); length 350 feet.
- Dam 1 (sheet 1), built in 1875, was raised to an elevation of 5 feet above low water.
- Dam 6 (sheet 4), spur from right bank, opposite head of Island 9, commenced in July; length, 880 feet.
- Dam 2 (sheet 1), spur from left bank 1,700 feet above Island No. 1, completed; length, 450 feet.

Shore protection on head of Island No. 1 was repaired and extended 150 feet.

Dam 2 (sheet 3), from right bank to Island No. 5, built in 1878, was raised to 5 feet above low water.

Dam 9 (sheet 3), across mouth of slough on left bank above Island No. 9, length 140 feet.

Shore protection on Island No. 17 commenced.

Dam 2 (sheet 5), built in 1875, raised to 5 feet above low water.

In September.—Shore protection on Island 17; commenced in August; length, 700 feet.

Dam 7 (sheet 5), spur from right bank below King's Lake; 400 feet long.

Dam 2 (sheet 5) raised to 5 feet above low water.

Shore protection on left bank from mouth of Nininger Slough to point opposite Dam 7 (sheet 5); length, 4,860 feet.

Dam 4 (sheet 6), spur from right bank below Dam 7 (sheet 5); 650 feet long.

Dam 5 (sheet 6), spur from right bank 1,600 feet below Dam 4 (sheet 6); 600 feet long.

Dam 4 (sheet 6), spur from right bank 1,200 feet below Dam 7 (sheet 5); 400 feet long.

Shore protection entire length (1,900 feet) of east shore of Island No. 13.

Dam 7 (sheet 4), spur from left bank opposite foot of Island No. 13; 400 feet long; commenced.

Shore protection on right bank from foot of Boulanger Slough up-stream 600 feet.

Dam 8 (sheet 4), spur from left bank, 1,658 feet below Dam 7 (sheet 4); 400 feet long; commenced.

In October.—Shore protection opposite Dam 8 (sheet 4); 1,200 feet long.

Dam 8 (sheet 4) finished.

Dam 7 (sheet 4) finished.

Shore protection on Island No. 13, commenced in September.

Shore protection on Island 16, 700 feet.

Shore protection Island 15.

Shore protection on west side of Island 17 repaired.

Dam 1 (sheet 5), from left bank to Island 17, raised and repaired.

In November.—Shore protection, Island 16, commenced in October.

Shore protection on right bank, opposite Island No. 1, 1,000 linear feet.

Dam 2 (sheet 5) raised and repaired.

Dam 13 (sheet 2), spur above Red Rock, opposite Island No. 2, 400 feet.

Dam 14 (sheet 2), 1,200 feet below Dam 13 (sheet 2), 375 feet in length, commenced.

On account of cold weather and ice in the river work was closed November 15 and the fleet put in winter quarters in Boulanger Slough.

Work has not yet been resumed this season on account of high water.

ALMA, WISCONSIN, TO READ'S LANDING, MINNESOTA.

Operations were carried on in this stretch of river by hired labor and purchase of material in open market, the United States tow-boat No. 2, steam-launch No. 2, and fleet of barges being used for transporting the material and putting it in place. Work was begun July 19, 1882, and continued without interruption until November 19.

The following work was accomplished:

In July Dam 3 (sheet 13) from right bank to Drury's Island was raised to a height of 5 feet above low water. Spur-dam 1 (sheet 13) was also raised to same height.

Repairs of Dam 3 (sheet 14) were commenced and 75 feet of shore protection constructed.

In August the work of the month consisted principally in raising and repairing dams and shore protections, commenced in 1881 and left in an unfinished condition on account of high water.

Repairs of Dam 3 (sheet 14) were completed, and two dams, 17 and 18 (sheet 14), were put in above the mouth of the Zumbro River.

The raising of Spur-dam 9 (sheet 14) was nearly completed.

The work of the month was seriously delayed by the failure of contractors to furnish rock in sufficient quantities, teams being engaged in harvesting and difficult to obtain.

In September the raising of Dam 9 (sheet 14), commenced in August, was completed.

Dam 10 (sheet 14), spur from right bank of island below Crat's, was raised for a length of 500 feet.

The upper end of Island No. 32 and its west side were protected for a distance of 675 feet; also its lower end, 140 feet.

West side of Island No. 34 was protected for a length of 1,140 feet.

Dam 6 (sheet 14) above Grand Encampment Island was raised to an elevation of 5 feet above low water.

Dam 12 (sheet 14) was similarly raised.

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In October the raising of Dams 13 and 14 (sheet 14), commenced in September, was completed.

Two small chutes in West Newton Island were closed and 300 feet of shore protection constructed.

Shore protection on head of Island No. 46 was repaired and extended down-stream on west side 300 feet.

Dams 1 and 2 (sheet 15), begun in 1881, were finished.

In November shore protection 800 feet long on tow-head in Pomme de Terre Slough.

Spur-dam 18 (sheet 14) was built with shore protection 500 feet in length.

On November 19, on account of cold weather, the fleet went into winter quarters at Wabasha, Minn.

Work in 1883 is not yet resumed on account of high water.

Mr. C. A. Lightner on Plant No. 1 and Mr. A. J. Stibolt on Plant No. 2 deserve credit for efficient service.

MOUNT VERNON TO FOUNTAIN CITY.

Operations in 1882.—The contractor, Jacob Richtman, of Fountain City, began work October 18. Shore protection was placed around the head of Island No. 53 and along the north and west sides. This revetment was built very heavy and is 1,077 feet in length and from 22 to 35 feet in width. This protection was designed to preserve the bank after the construction of the proposed dam across the chute. The next works were the construction of Dam 7 (sheet 16), extending from Island No. 15 to a tow-head and thence to the Minnesota shore, closing the chute, and shore protections at the ends of the dam, and on the tow-head. As constructed, the dam is 885 feet in length, the shore protection 868 feet. On completion of the dam, operations were stopped for the season, November 25.

Operations in 1883.—Operations were resumed April 26, and continued without intermission until June 9, when the contract was completed. The dams and shore protections constructed were as follows: Closing Dam 6 (sheet 16), running from Island 53 to the Wisconsin shore; 500 linear feet of shore protection on Island 55, commencing at the shore end of the dam, running around the head of the island and down the western bank; 300 linear feet of shore protection on Island No. 58, commencing at a point about 100 feet below Station M (survey 1882) and running down the right hand bank, and repairing a break in Dam 7 (sheet 16).

Summary of work.

Years.	Locality.	Linear feet.	Rock.	Brush.
			<i>Cu. yds.</i>	<i>Cu. yds.</i>
1882.....	Shore protection head Island 53.....	1,077	1,758.29	1,324.38
1882.....	Shore protection on Sand Island and Muni shore and dam 7 (sheet 16).....	1,753	1,910.37	1,455.72
1883.....	Dam 6 (sheet 16).....	1,350	3,431.25	2,871.95
1883.....	Shore protection head Island 55.....	500	419.92	448.98
1883.....	Shore protection Island 58.....	300	330.16	271.20
1883.....	Dam 7 (sheet 16), repairs.....		104.47	40.47
	Total.....		7,954.46	6,442.70

LA CROSSE TO BROWNSVILLE.

Contractor P. S. Davidson commenced operations October 6, 1882, and closed for the winter November 27; resumed April 9, 1883, and completed his contract June 1.

Operations in 1882.—Dam 2 (sheet 21), built in 1877, was raised to an elevation of 4 feet above low water after several breaks in it had been repaired. It now has a uniform width of 8 feet on top and extends from Bates Island to the Minnesota shore. Fourteen hundred linear feet of shore protections were constructed at La Crescent, extending from the dam to the ferry landing. One thousand six hundred and eleven linear feet of shore protection were put in on the east shore of Grand Island, having an average width of 16 feet. Some repairs were made to the shore protection at the Government light.

Operations in 1883.—Dam 1 (sheet 22), closing Fish Slough, the channel between Island 110 and the Minnesota shore. This dam required seven courses of brush in the deepest water to build it to an elevation of 5 feet above low water. There was also constructed in connection with the dam around head of Island 110, 1,305 linear feet of shore protection of an average width of 18 feet. Dam No. 2 (sheet 22), closing Crosby Slough, required three courses of brush to bring it to grade. In connection

with this dam about 775 feet of shore protection were constructed around head of Island 117. Dam No. 3 (sheet 22), closing chute between Island 116 and the Minnesota shore, required five courses of brush in the deepest water. Some 675 linear feet of shore protection were constructed, part on Minnesota shore and part around head of Island 116.

Summary of work.

Years.	Locality.	Linear feet.	Rock.	Brush.
			<i>Cu. yds.</i>	<i>Cu. yds.</i>
1882	Dam No. 2 (sheet 21) raised		1,233.04	103.49
1882	Shore protection at La Crescent	1,400	1,936.95	1,448.68
1882	Shore protection at Grand Island	1,611	1,414.97	892.54
1882	Shore protection at Government light		63.68	
1883	Dam 1 (sheet 22)	325	1,226.27	813.09
1883	Shore protection head Island 110	1,305	899.03	750.60
1883	Dam 2 (sheet 22)	300	938.39	727.38
1883	Shore protection head Island 117	775	622.49	528.20
1883	Dam 3 (sheet 22)	200	507.40	464.96
1883	Shore protection head Island 116	675	468.19	378.85
1883	Repairing shore protection, La Crescent		57.10	
Total			9,367.36	6,102.79

HOMER TO QUEEN'S BLUFF.

Contractor Davidson began operations in this locality June 9, 1883. The work accomplished to July 1 is as follows:

Dam 1 (sheet 19), closing the channel between Island 76 and the Minnesota shore, is nearly completed.

It required four courses of brush in the deepest water. There have been 750 linear feet of shore protection placed around head of Island 76.

Summary of work.

Years.	Locality.	Linear feet.	Rock.	Brush.
			<i>Cu. yds.</i>	<i>Cu. yds.</i>
1883	Dam 1 (sheet 19)	600	1,011.25	1,002.13
1883	Shore protection head Island 76	750	714.87	637.63
Total			1,726.12	1,639.76

SURVEYS.

A number of surveys of detached localities between Saint Paul and Alma were made in summer and fall of 1883 by Mr. G. A. Marr, assistant engineer, as given in the following extracts from his report to me:

"On July 24, received orders from you to make a survey of the river from Saint Paul to Kaposia, said survey to give numerous soundings and full details in regard to Frenchman's and Pig's Eye Bars. This survey was made with a small party of from five to six men with a skiff, and was completed August 19. Maps were then made in the office and completed August 26, except tracings, which were made the next week by Mr. H. L. Phillips, who remained in the office for that purpose.

"This survey extended from about 1,200 feet above the bridge at the foot of Wabasha street, Saint Paul, down the river to just below Pig's Eye Island.

"After this work was completed orders were received to make surveys at the following places: Wabasha, Minn., to Alma, Wis.; Mount Vernon, Minn., to Fountain City, Wis.; Homer, Minn., to Trempealeau, Wis.; and from La Crosse, Wis., to Brownsville, Minn.

"Some work of locating dams above Hastings, Minn., was done the last of August, and the survey at Wabasha, Minn., was commenced September 1.

"This work consisted of a complete survey from the railroad bridge at Read's Landing, Minn., to the lower end of the city of Alma, or about 12 miles of the main channel of the river. The survey was completed September 26, having had the steam launch Mary for the work after September 9.

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"Left Wabasha for Trempeleau September 27, and commenced survey at that point September 28. The survey was carried about 1 mile above Homer, Minn., and extended down the river to Queen's Bluff. This section of river includes the narrow channels of Homer Chute, or Blacksmith's Slough, and Richmond Chute. These are portions of the river where navigation is rather precarious at a low stage of water.

"The survey at this point included all the large sloughs, and covered about 13 miles of the main channel.

"While at Trempeleau, Wis., received orders from you in regard to locations and general instructions to inspectors for contract work being done at La Crosse, Wis., by P. S. Davidson, esq., and at Fountain City, Wis., by Jacob Richtman, esq. This work was attended to when necessary in connection with the survey work.

"Closed work at Trempeleau on October 14, and left with party for the survey at La Crosse, Wis. Commenced this survey on Monday, October 16, and a complete survey was made from the railroad bridge at La Crescent, Minn., down to the head of Coon Slough, making about 16 miles of the main channel surveyed at this place.

"The work was completed October 31, and on November 1 the party was moved up to Fountain City, Wis., where a survey was commenced on November 2, which extended from Fountain City up the river to the foot of Island No. 51, and including the Rollingstone Channel or Horse Shoe Bend.

"This survey was suspended on November 15, on account of cold weather, and the steam launch Mary was taken to Wabasha, Minn., and laid up for the winter, being taken out of the water.

"After inspecting the contract work at La Crosse on the 16th, and locating the dam opposite Wabasha on the 17th, returned to the office on November 18.

"The amount of survey work done from July 25 to November 18 was as follows:

	Miles.
"In the vicinity of Saint Paul, about	5
"In the vicinity of Wabasha, about	12
"In the vicinity of Fountain City, about	8
"In the vicinity of Trempeleau, about	13
"In the vicinity of La Crosse, about	16
Total	54"

The notes of the surveys were plotted during winter and spring, and the maps are now nearly completed.

Very respectfully, your obedient servant,

J. L. GILLESPIE,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. E. F. HOFFMANN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 2, 1883.

MAJOR: I have the honor to submit the following report on works in my charge for fiscal year ending June 30, 1883:

I.—RUSH CHUTE AND SHOKOKON SLOUGH.

Operations were begun September 11, and carried on by day's labor and purchase of material in open market, tow-boat No. 3, steam launch No. 3, and a fleet of barges being employed in transporting the material and putting it in place.

(A)—*Dam 1 (sheet 58), Rush Chute.*—The protection at west end of this dam was rebuilt from the dam to a point 240 feet below, 20 feet wide, and extending to the top of the bank, this work being necessary as the original protection had been destroyed.

The protection above the dam on the head of Rush Island was repaired. The dam itself was repaired near its west end, where it had settled somewhat.

The repairs consisted in placing a mat 60 feet long and 20 feet wide below the dam to form an apron, and raising the dam about 1 foot for 60 feet of its length.

(B)—*Shore protection, Island 376.*—The work at this place consisted in protecting the bank around the head of the island for a length of 270 feet, width of protection 25 feet, and extending to top of bank.

(C)—*Dam 1 (sheet 59), Shokokon Slough.*—This dam was commenced in 1881, but the work was interrupted by high water. Operations were resumed September 13, 1882, and the work was completed during the season.

The dam is 1,000 feet in length and closes the east branch of Shokokon Slough. The apron consists of one course of brush and rock, and is 15 feet wide.

On the line of dam three courses of mats were laid. A mat of about 80 feet in length was also sunk, covering a space in the apron which had been damaged.

When three courses of brush and rock had been laid, the fall of water became so great as to cause serious trouble in handling brush, and consequently the use of brush was discontinued on September 29, after which date rock alone was used in the construction of this dam. In order to prevent waste of material and facilitate the work, a change in the plan of operations was necessary.

A barge was placed endwise on line of dam and fastened to the construction-boat above the dam. Above the end of this barge, on line of dam, a grating was made by putting in poles 4 to 6 inches in diameter, and about 6 inches apart, the lower ends resting on the dam and the tops resting against the barge.

In front of this grating, rock was dumped, forming piers about 15 feet wide, and carried to a height of 2 to 3 feet above surface of water; rock was also placed back of the grating and the poles were then cut off.

These piers were placed about 20 feet apart; when piers had been formed extending across the slough, the spaces between were closed in the same manner, using the grating.

The dam was closed November 4, the stage of water above low water of 1864 being 7 feet, the fall over the dam being 4.75 feet. The difficulties at this dam were greatly increased by a rise in the river of 3 to 4 feet, which also required the dam to be brought to a height of 7.5 feet above low water to be able to close it instead of 6 feet, as originally designed.

Only one party of a limited number of men was able to engage in the work during a greater part of the time. The total quantity of material put in Dam 1 (sheet 59) is as follows:

Season of 1881, rock, cubic yards.....	1,055 00	
Season of 1881, brush, cubic yards.....	1,340 00	2,395.00
Season of 1882, rock, cubic yards.....	9,691.97	
Season of 1882, brush, cubic yards.....	1,594.12	11,286.09
Grand total	13,681.09	

The crest of this dam is only about 4 to 5 feet wide, as, owing to lack of rock, it was not possible to increase this width. This dam cannot be termed finished and it may be desirable to increase its width as soon as possible or practicable.

The shore protections of this dam were increased in width by sinking a mat 16 feet wide at the outer edge of the protection put in the previous year; this mat extends the entire length of the protections. At the ends of the dam the protections showed signs of weakening and were partly taken up and replaced. In the angles on upper side of dam the shores were further protected by the use of straw, fine stone, and earth, to prevent, as far as possible, the water from getting behind the protection and cutting the bank.

(D)—*Dam 2 (sheet 59), Shokokon Slough.*—This dam, extending across the west branch had been partly completed during the season of 1881, but work was interrupted by running ice.

During the season of 1882 work on this dam consisted of putting in shore protections at ends of dam, which had been prevented the previous year by high water and raising and straightening the dam.

The shore protections consist of the usual layer of brush and rock, about 160 feet long, 30 feet wide, extending to top of bank.

The dam was brought to a height of 6 feet above low water and made about 5 feet wide on crest, the slope on upper and lower sides of dam being about 1 on 1.

During the high water a part of the crest of this dam was carried away; some repairs were made in November, but were not entirely finished, owing to failure in obtaining rock; two gaps about 25 feet wide were left, with 6 inches to 1 foot of water running over.

The material in Dam 2 (sheet 59) is as follows:

Season of 1881, rock, cubic yards	5,120.21
Season of 1882, rock, cubic yards	2,022.78
Season of 1882, brush, cubic yards.....	290.00
Total cubic yards	7,432.99

It will probably be necessary to increase the strength of this dam during the coming season; much sand has been deposited above and below the dam.

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(E)—*Small dam on Burlington Island.*—About 300 feet above Dam 2 (sheet 59) and 80 feet back from the shore-line of Burlington Island, a narrow slough was closed by a dam consisting of one course of brush 80 feet long, covered with rock 1 to 3 feet in thickness.

Quantities of material put in works near Burlington, 1882, September 11 to November 13.

Works.	Length.	Rock.	Brush.	Total.
	<i>Feet.</i>	<i>Cu. yds.</i>	<i>Cu. yds.</i>	<i>Cu. yds.</i>
Dam 1.58, shore protection.....	240	539.45	230.00	769.45
Shore protection Island No. 876.....	270	208.08	295.20	503.28
Dam 1.59.....	1,000	9,691.97	1,504.12	11,196.09
Dam 2.59.....	900	2,022.78	290.00	2,312.78
Dam near D, 2.59.....	80	61.88	80.00	141.88
Total.....		12,524.16	2,489.32	15,013.48

Work was suspended November 13, and the entire plant, excepting tow-boat No. 3, was laid up in winter quarters on the 14th of November in the Keokuk Canal.

II.—WORKS NEAR MONTROSE, IOWA.

During the early part of the season it was found that to maintain a navigable channel at the head of Montrose chain immediate attention was necessary.

The Government dredge was therefore placed at work removing sand and rock, and on September 13 operations were begun in the construction of dams, and during the following month Dams A, B, C were completed.

Dam A is a prolongation of the dike at head of the rapids, and extends from the end of dike up-stream 540 feet. It is of the usual construction of brush and rock, and is built to a height of 4 feet above low water.

Dam B is a closing dam in the small slough dividing Montrose Island. Its construction is that in general use, and is built to a height of 4 feet above low water.

Dam C is simply a single mat 45 feet long, covered with rock and placed in low ground, to protect the end of Dam B in high water.

Revetment D was started on October 14. This protection, 300 feet in length, is carried around the head of Montrose Island, and extends 60 feet below line of Dam E, forming the shore protection to this dam. Directly on the head of the island, as a measure of precaution, the thickness of the rock was increased to 2 feet, that the bank might be amply protected from the increased attack which the proposed closing of French channel must ultimately produce.

Dam E was begun October 29. The presence of rock bottom over the entire line of dam permitted its completion, as the work progressed without danger of wash being incurred. As proposed, this dam is to be 2,100 feet in length, extending across French Channel, and is to be built to low-water elevation.

French Channel is now the avenue through which a large quantity of water wastes itself, and its stoppage must produce beneficial results in the channel at Montrose.

The cross-section beyond the proposed end of the dam is small, and owing to rock bottom cannot vary except with change of stage.

In Dam E one, two, or three courses of mats were laid, to suit the requirements of varying depths of water. Building to low water is experimental, and in case this elevation does not produce the desired result the height can be increased. The dam was completed for a length of 1,250 feet from shore; the shore end, for a distance of 60 to 70 feet, was raised to a height of 3 feet above low water, with a view to economize material, as well as to afford greater security to the shore below the dam. Although the weather was not favorable, the work was continued until November 15.

Table of quantities.

Description.	Length.	Rock.	Brush.	Total.
	<i>Feet.</i>	<i>Cu. yds.</i>	<i>Cu. yds.</i>	<i>Cu. yds.</i>
A.—Dam.....	540	740.64	494.00	1,234.00
B.—Dam.....	100	148.13	100.00	248.13
C.—Mattress.....	45	20.00	15.00	35.00
D.—Revetment.....	300	1,020.96	240.01	1,260.97
E.—Dam.....	1,250	1,307.95	1,701.00	3,008.95
Total.....		3,287.68	2,650.01	5,887.69

On the 15th of November the United States tow-boat No. 4 and fleet were laid up in the Des Moines Rapids Canal for the winter. Tow-boat No. 4 performed valuable service during the period of operations, and when not towing in the interest of the works had ample time to attend to the requirements of the Government dredge.

I take pleasure in mentioning the services of Inspector J. D. Du Shane, who, in local charge of the work in Shokokon Slough, performed his duties with zeal and ability.

Very respectfully, your obedient servant,

E. F. HOFFMANN,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

W 3.

IMPROVEMENT OF THE MISSISSIPPI RIVER FROM DES MOINES RAPIDS TO MOUTH OF ILLINOIS RIVER.

With this appropriation works for the benefit of through navigation are carried on at points selected each year in accordance with the needs of navigation.

At the beginning of the year our projects included continuance of work at Gregory's Landing and inauguration of new works at Dixon's Landing, Dardenne Island, and Cap au Gris.

All of these works were undertaken, that at Gregory's Landing by contract and the others by hired labor and purchase of material in open market, the United States tow-boat No. 5 and plant being used for handling the rock and putting the same in place.

Work has not been resumed in 1883 on account of high water, except in vicinity of Louisiana, where a small amount of work has been done under contract.

GREGORY'S LANDING.

Work at this locality was completed in November, 1882. The original project included the construction of a dam 1,805 feet in length, from Hackley's Island to the tow-head, and the protection of a long piece of caving bank above Fox River. The project was afterwards enlarged by including a dam across Hackley's Chute, some shore protection in the chute and in front of Gregory's Landing.

The contract was awarded to Whitney & Son in August, 1880, but the work was so much interfered with by high water that the contractors were given until December 31, 1882, to complete the work.

Some additional quantities of material were added to the original estimate in order to cover the work in Hackley's Chute, and this material was put in place at the contract price.

Operations during the present fiscal year began September 12, 1882, and the entire work was completed November 2.

SUMMARY OF WORK FOR FISCAL YEAR ENDING JUNE 30, 1883.

11,855.22 cubic yards rock, at \$1.55	\$18,375 59
9,778.94 cubic yards brush, at 90 cents	8,801 05
Superintendence and office	1,558 00
Total.....	28,734 64

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Final statement.

Years.	Rock.	Brush.	Cost of materials.
	<i>Cu. yds.</i>	<i>Cu. yds.</i>	
1880	3,054.43	3,242.60	\$7,652 71
1881	2,185.16	1,551.53	4,783 36
1882	12,205.22	10,178.94	28,079 13
Total	17,444.81	14,973.07	40,515 20

The work accomplished is as follows:

Dam from Hackley's Island to tow-head, 1,805 feet in length; dam across Hackley Chute, 320 feet; shore protection above Fox River, 3,580 linear feet; shore protection at Gregory's Landing, 600 feet.

BOLTER'S ISLAND, DARDENNE ISLAND, AND CAP AU GRIS—OPERATIONS OF TOW-BOAT NO. 5 AND BARGES.

On account of the high water, tow-boat No. 5 was not put in commission until August 10.

Work was then commenced on the closing dam (No. 1, sheet 83), between Island 513 and Island 514 (Dardenne). This dam, 1,510 feet in length, was built to a height of 6 feet above low water.

The adjacent shores were also protected by a brush and stone revetment for a distance of 1,100 feet.

The next work undertaken was the construction of the closing dams between islands 512 and 514 (Nos. 1 and 2, sheet 82).

They were built to an elevation of 7 feet above low water, and, including shore protections, are 1,748 feet in length.

On completion of the above work the fleet was moved up to Cap au Gris and 1,607 linear feet of shore protection was constructed on the heads of Islands 500 and 501.

Unfavorable weather and the necessity of making some repairs to wing-dam at Hannibal before the end of the season caused a suspension of operations November 17.

The repair work at Hannibal was begun but could not be completed before cold weather set in.

An examination made in May, 1883, showed much improvement in the crossing at Dixon's Landing due to the construction of the closing dams.

All the dams and shore protections were in good condition.

SUMMARY OF COST OF WORK—BOLTER'S ISLAND, DARDENNE ISLAND, AND CAP AU GRIS.

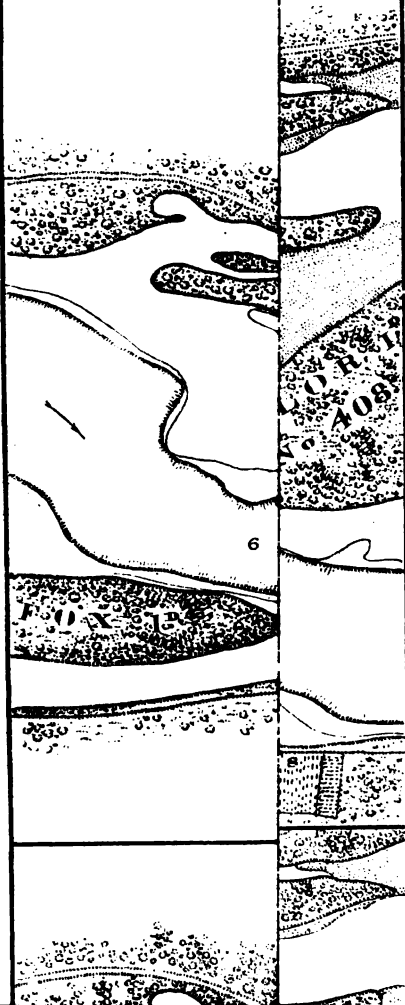
21,936 cubic yards rock, at 50 cents	\$10,968 00
Brush (6,885 cubic yards), labor, subsistence, fuel for steamer, &c	20,388 06
Superintendence and office expenses	1,813 40
Total expended	33,169 46

Total material, 28,821 cubic yards.

Average cost per yard, \$1.15.

Details of the work are given in accompanying report of Mr. O. N. Chaffee, assistant engineer, who has managed the operations of Plant No. 5 and the quarry at Dixon's Landing with economy and success.

IMPROVEMENTS in Riv.



HANNIBAL.

The original project for work at this locality included the removal by dredging of the large gravel bars on the Hannibal shore and in mid-river, and also the construction of three wing-dams extending from the Illinois shore and one closing dam in Glasscox Island Chute, the object of the dams being to confine the current to the Hannibal shore, and thus prevent further deposits.

The closing dam and lower wing-dam were built in 1881 and 1882.

A survey made in March, 1883, showed a great increase in size and height of the bar extending along the Illinois shore from the bridge to Glasscox Island.

This shoaling had been anticipated and provided for in the original project, which says:

The shoaling caused by these dams will probably destroy the present ferry landing, and therefore one of the dams should be built in the form of a causeway, furnishing a new landing in deep water.

In order to hold the bar as it now is, and at the same time to cause as little injury as possible to the ferry traffic, it was determined to build the causeway at once.

As designed, it is 800 feet in length and 15 feet on top, so that it can be used by wagons, and it is connected with the county road.

There being plenty of gravel near at hand, and it having been in former years demonstrated that gravel makes an excellent dam, an agreement was made with H. S. Brown, of Quincy, to construct the base of gravel at the rate of 25 cents per cubic yard.

The river fortunately remaining at a good stage for dumping the material on the dam, the gravel was carried up much higher than was originally intended, and by so doing a great saving in the quantity of rock required will be made.

The gravel was dredged from the bad bars in front of Hannibal, and the work was of great benefit in that respect.

Details are given in accompanying report of Assistant Engineer C. W. Durham.

QUINCY REVETMENT.

The river and harbor act passed August 2, 1882, contained the following clause:

For the improvement of the Mississippi River * * * two hundred thousand dollars, from the Illinois River to the Des Moines Rapids, including a stone and brush revetment at or near Quincy.

Soon after the passage of the bill an examination of the locality was made, and it was decided to protect the shore by a brush and stone revetment from Big Slough to a point about 500 feet below the Government light. An allotment of \$20,000 was set aside for the purpose.

Proposals were called for, and the contract was awarded to H. S. Brown, of Quincy, November 12, 1882.

On account of the lateness of the season very little work was done before the river was closed by ice. It has been impossible to do satisfactory work thus far this season on account of extreme high water, and for that reason the time for completing the contract has been extended from June 30 to November 1, 1883.

VICINITY OF LOUISIANA, MISSOURI.

The river in vicinity of Louisiana, and more especially below the bridge, has been bad for several years, and boats have met with much trouble during the past three seasons.

The original project for work at Louisiana, rendered December 22, 1880, called for a wing-dam extending from the Illinois shore at a point near the ferry landing, above the bridge, and for a wing-dam and two closing dams below the bridge, the latter in Buffalo and Brokaw Chutes.

The wing-dam above the bridge was built in 1881, under appropriation of March 3, but no more funds being appropriated for this special purpose, it was decided to allot \$50,000 from the general appropriation of August 2, 1882, for carrying on the project. Proposals were called for for building brush and stone dams, and the contract was awarded, November 9, to Paterson Brothers, the lowest bidders, at \$1.55 per cubic yard for rock and 95 cents for brush.

It was then too late in the season to begin operations in the field, although the contractor kept a force during the winter quarrying rock.

A survey made in March, 1883, showed that many changes had taken place in position of channels and bars since the survey of the year before, and it became necessary to change the location of the proposed dam somewhat.

Work was commenced April 21, and has continued with much delay on account of high water to date.

Dam No. 3, 2,000 feet in length, has been completed for about three-fourths of its length, and the remaining fourth is in a fair state of progress.

On account of delays experienced through floods in the river, the time for completion of the contract has been extended from June 30 to November 1, 1883.

Details of the work are given in the report of C. W. Durham, assistant engineer.

SNAG-BOAT J. G. PARKE TOWING BARGES FROM THE OHIO RIVER.

About the time the *Parke* was completed at Jeffersonville, Ind., six model barges, built for the Government for use in Upper Mississippi River improvements—three at Jeffersonville and three at Metropolis—were also ready.

It was an advantage for her to bring them around into the Upper Mississippi River, and she was accordingly employed for the purpose. Three of the barges were loaded with oak lumber for use in Government work.

SNAG-BOAT GENERAL BARNARD.

The appropriation for operating the *General Barnard* being insufficient an allotment was made from this appropriation. On her return from transporting supplies for sufferers from overflow of the Lower Mississippi River, she was taken to Dubuque and thoroughly repaired and repainted.

SURVEYS AND GAUGES.

Several surveys have been made during the year for ascertaining results of works already constructed and for planning new ones. Maps of surveys at Dixon's Landing, Cap a Gris, Hannibal, and Louisiana have been completed and are now on file in the office.

PURCHASE OF AND REPAIR TO PLANT.

Six model barges built on the Ohio River were received and employed during the latter part of the season of 1882. A dredge and six dump

scows have been received from the builders and will be ready for service by the end of July.

The entire fleet has been put in thorough repair.

QUARRY AT DIXON'S LANDING.

The quarry at Dixon's Landing, opened for the purpose of obtaining rock for use in building dams and shore protections, was kept in operation until April 3, 1883.

The total quantity of stone quarried during the year is estimated at 46,336 cubic yards, of which 21,936 cubic yards were used in the works last season, leaving a quantity still in store amounting to 24,400 cubic yards. The cost of the rock, including its quota of office expenses and contingencies, was about 50 cents per cubic yard.

QUARRIES IN KEOKUK CANAL.

A small quantity of rock was quarried in the canal, but the stripping being very heavy it could not be gotten out economically and the work was stopped.

CURRENT METER OBSERVATIONS.

Assistant G. A. Marr was employed during a part of the year in the reduction of current meter observations made under direction of Maj. F. U. Farquhar in 1878 and 1879. A progress report on this subject was made in June, 1881, and is contained in my report for that year. The final report of Assistant Marr, with tables and plates will be forwarded hereafter.

SUMMARY OF EXPENDITURES FOR FISCAL YEAR ENDING JUNE 30, 1883.

Gregory's Landing and Hackley's Chute	\$30,944 39
Cap au Gris, Bolter's Island, Dixon's Landing, and repairs to Dam No. 2, at Hannibal, operations of tow-boat No. 5 and barges	21,262 66
Quarries at Dixon's Landing	23,186 09
Quincy revetment	282 59
Louisiana (Dam No. 3)	9,730 94
Hannibal (Dam No. 3)	3,521 64
Surveys, gauges, and meter work	3,050 31
Purchase and repairs of plant	20,645 58
Dredge and dump scows	23,149 83
Snag-boat General Barnard	5,980 53
J. G. Parke, towing barges	3,941 62
Quarries in Keokuk Canal	892 94
	<hr/>
	146,589 12

NOTE.—Of above amount \$48,750 was reported as outstanding liabilities July 1, 1882.

GENERAL REMARKS.

The general system of improvement followed on this section of river has been fully given in former reports and will not be here repeated.

The comparatively small appropriations under which this work is carried on do not permit any general order of improvement and necessitates each year the selection of a few of the points which for the time being are the most troublesome. To carry out this method a large plant has been provided and material collected and at the shortest notice improvements at any point can be inaugurated.

As soon as the present high stage of the river subsides sufficiently to

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permit of working to advantage, improvements will be made at Marion City, at and above Hannibal, and at Dixon's Landing.

As the Government is now provided with the plant and outfit needed for carrying on extensive operations, and as an economical method of working requires liberal appropriations, it is hoped that this section of the river may be granted the sum of \$500,000 for the fiscal year ending June 30, 1885.

ABSTRACT OF APPROPRIATIONS.

By act approved June 18, 1878.....	\$100,000
By act approved March 3, 1879	40,000
By act approved June 14, 1880.....	100,000
By act approved March 3, 1881.....	175,000
By act passed August 2, 1882	200,000
	<hr/> 615,000

Money statement.

July 1, 1882, amount available	\$47,479 67
Amount appropriated by act passed August 2, 1882	*200,000 00
	<hr/> 247,479 67
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$97,073 84
July 1, 1883, outstanding liabilities	5,978 82
	<hr/> 103,052 66
July 1, 1883, amount available.....	144,427 01
Amount that can be profitably expended in fiscal year ending June 30, 1885.	500,000 00

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, Rock Island, Ill., at 2 p. m., November 7, 1882, for building brush and stone dams and shore protections in vicinity of Louisiana, Mo.

No.	Names and residences of bidders.	Brush.	Stone.	Aggregate.
		<i>Per cu. yd.</i>	<i>Per cu. yd.</i>	
1	H. S. Brown, Quincy, Ill.	\$1 25	\$1 76	\$3 01
2	Patterson Bros., Keokuk, Iowa*	85	1 65	2 40
3	Fruin & Co., Saint Louis, Mo.	86	1 58	2 44
4	A. J. Whitney, Keokuk, Iowa	1 20	1 75	2 95

* Contract awarded.

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, Rock Island, Ill., at 2 p. m., November 7, 1882, for building brush and stone revetment below Quincy, Ill.

No.	Names and residences of bidders.	Brush.	Stone.	Aggregate.
		<i>Per cu. yd.</i>	<i>Per cu. yd.</i>	
1	H. S. Brown, Quincy, Ill.	\$0 90	\$1 40	\$2 30
2	Patterson Bros., Keokuk, Iowa	90	1 80	2 70
3	A. J. Whitney, Keokuk, Iowa	1 00	1 65	2 65

* Appropriated under head of "Improving Mississippi River" * * * "from the Illinois River to Des Moines Rapids."

† Contract awarded.

REPORT OF MR. O. N. CHAFFEE, ASSISTANT ENGINEER.

QUINCY, ILL., July 2, 1883.

MAJOR: I have the honor to present a report of operations under my control during the fiscal year ending June 30, 1883.

QUARRYING ROCK.

Work of preparing stone at the United States quarry near Dixon's Landing, Ill., was continued until April 3, 1883, by a force varying from thirty to ninety men. At that date, the whole quarry had been worked over, and no more space remaining for handling material, nor works in progress to which it could be removed, work was suspended and the force discharged. The total quantity of stone quarried during the year, is estimated at 46,336 cubic yards; the quantity removed to works constructed is 21,936 cubic yards; balance on hand at quarry is 24,400 cubic yards. The cost of quarrying has been 48 $\frac{1}{4}$ cents per cubic yard, which also includes expense of opening and stripping the quarry throughout its whole length, about 1,900 feet, and piling the stone now on hand from 4 to 10 feet high.

CONSTRUCTION.

On account of high water in Mississippi River, work of construction was not begun until August.

The fleet was placed in commission on the 10th, and operations begun in the vicinity of Fruitland at the tow-head above Bolter's Island, whence a dam, No. 1 (sheet 83) was projected to extend to Dardenne Island, a distance of 150 feet. After 1,100 feet of the shores had been protected at the ends of the dam, it was built at first to an elevation of 4 $\frac{1}{2}$ feet above low water of 1864, and was then well above the surface at the existing stage. Later in the season, after some time had elapsed to allow it to settle, it was raised to a height of 6 feet above low water.

The greatly increased current around Bolter's Tow-head, made necessary some repairs to the protection before the end of the season. At my last visit to the locality in May, both the dam and protections were in good condition with every appearance of stability.

The quantity of material used was 14,229.41 cubic yards of brush and stone, at a cost, in place, of \$15,231.81, or \$1.07 per yard.

The next work undertaken was the closing dams and shore protections from Apple Island to head of Dardenne Island (Dams Nos. 1 and 2, sheet 82), situated about 2 miles above the last work, and with it designed to improve the crossing between them which had been a considerable obstruction to navigation for several years. The length of the dams and shore protections was 1,748 feet. The dams were built to an elevation of 7 feet above low water, and remained in good condition at the time of my last visit in May, though probably somewhat lowered by ice:

Quantity of material used, cubic yards	8,863.47
Total cost in place	\$11,542.25
Cost per cubic yard	1.30

The increased cost over that of preceding work was caused by difficulty of approach to the site of the works. Much of the material was wheeled more than 200 feet.

The results accomplished by these works were all that had been anticipated. Soon after the upper dams had been thrown across, the channel began to deepen on the crossing below, and no trouble has been experienced there since that date. Recent surveys indicate a depth of over 4 feet below low water of 1864.

On the completion of these works the construction party was removed to the vicinity of Cap au Gris, where difficult navigation had existed for several years.

Protection of the heads of islands 500 and 501 was commenced, and 1,607 feet completed.

The unfavorable character of the weather, and the necessity of making some repairs and additions to works near Hannibal before the end of the season, caused a suspension of operations here on the 17th of November:

Total amount of materials, cubic yards	5,284.6
Cost in place	\$5,495.80
Cost per cubic yard	1.04

Nine barges and quarter-boats of the fleet not required for service at Hannibal were placed in winter quarters at foot of King's Lake, above the village of Cap au Gris, where they have since remained without damage from ice or high water.

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Work of repairing the wing-dam (No. 2, sheet 7) and shore protection opposite Hannibal was begun as soon as the fleet could reach there with materials. The work was but partially performed when winter caused a suspension of operations.

Total quantity of material, cubic yards.....	1,325.63
Total cost in place.....	\$1,695.42
Cost per cubic yard.....	1.28

The remainder of fleet was laid up in Quincy Bay, where it has remained, with the exception of tow-boat No. 5, which was loaned to Major Suter, Corps of Engineers, on April 9.

In April and May I made surveys of portions of Mississippi River near Fruitland and Cap au Gris. The maps have been platted and transmitted to the office at Rock Island. At Fruitland the benefits to navigation due to our works are very decided.

The crossing has already cut out to a depth of over 4 feet below low water, and a still greater depth will doubtless be made as the water falls to a lower stage.

Considerable changes in the navigable channel near Cap au Gris which have taken place since the project for its improvement was made may indicate changes in the plans for future works.

Very respectfully, your obedient servant,

O. N. CHAFFEE,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 2, 1883.

MAJOR: I have the honor to present my annual report on the several works in my charge between Des Moines Rapids and the Illinois River for the fiscal year ending June 30, 1883.

AT HANNIBAL, MISSOURI.

A survey of the vicinity of Hannibal made in March, 1883, developed the necessity and importance of speedily constructing the causeway (Dam No. 3, sheet 71) as proposed in the original project for improvement in this locality.

The construction of Dams 1 and 2 had, as expected, caused a great increase both in the size and height of the bar extending along the Illinois shore from the bridge to Glasco Island. To preserve the good results obtained and prevent as far as possible injury to the ferry traffic, it was determined to build the causeway at once.

By means of the map of this survey I was enabled to locate the dam with due regard to economy and make a fair estimate of its cost. It was determined to build the base of the dam of gravel, carrying the gravel up as far as the stage of water would permit us to use dump-boats for the purpose, and to top off the dam with rock, so as to make a suitable roadway.

The location, dimensions, &c., of the dam as proposed were as follows: 800 feet long, on a line 21 degrees up-stream from line of county road, and connecting with the road; there will also be 100 feet of T-head; base of gravel carried up to 2 feet above low water; crest of rock to be carried up to 7 feet above low water; width on top, 15 feet; up-stream slope, 1 on 1; down-stream, 1 on $\frac{1}{2}$.

The estimated cost of the dam was \$5,500. An agreement having been made with H. S. Brown to place the gravel in the dam, work was begun April 2, 1883.

Fortunately the river remained at a high stage during the month, and we were able to carry up the gravel foundation much higher than we expected, thus making a saving on the rock, the more expensive material.

The gravel base was completed April 30, and the dam, as now constructed, is 800 feet long, about 70 feet wide on the bottom, and from 20 to 25 feet wide on top, with its crest between 6 and 7 feet above low water.

Only a comparatively small quantity of rock will be needed to finish the dam, which it is proposed to do in August.

SUMMARY OF WORK.

12,327.28 cubic yards of gravel, at 25 cents	\$3,018 82
Survey, inspection, and contingencies	439 82
Total expended	3,521 64

QUINCY REVETMENT.

The contract for this work, which is designed to protect from abrasion a long stretch of caving bank in the bend below Quincy, Ill., was awarded to H. S. Brown, of Quincy, Ill., the lowest bidder, November 12, 1882.

But very little work could be done before the river was closed by ice. No work has been done the present season on account of high water, the bank to be protected having been overflowed a great part of the time.

The work accomplished consists in a sill of brush and rock laid across Big Slough. This was built to serve as a wagon road for transportation of material as well as to prevent further scour in the slough.

SUMMARY OF WORK.

57.86 cubic yards rock, at \$1.40	\$81 00
210.77 cubic yards brush, at 90 cents	189 69
	270 69
10 per cent. retained	27 07
	243 62
Engineering and contingencies	27 35
Total expended	270 97

VICINITY OF LOUISIANA, MISSOURI.

Early in March, 1883, a survey of this locality was made by Inspector J. C. McElherne, extending from the saw-mill, at the upper end of the city, to the foot of Brokaw Island.

Numerous changes had taken place in the position of the sand-bars and channel since the survey of the year before, and in consequence it was necessary to modify the original plans to some extent as regards location of the dams.

It was decided to commence work on a wing-dam (No. 3, Sheet 75) extending from a point on the Illinois shore, nearly opposite the middle of Brokaw Island, 2,000 feet into the river.

The contractors, Patterson Brothers, commenced work April 21, 1883, and continued, with frequent interruptions on account of high water, until the end of the fiscal year. The dam is now completed for about 1,500 feet of its length, and brought up to a grade of 5 feet above low water. The remaining 500 feet, which crosses a deep pocket, will need about ten additional courses to bring it up to grade. It is hoped that the effect of the dam will be such in deepening the river near its outer end as to permit the closing of Buffalo Chute, the present channel, which is too narrow for the proper accommodation of navigation.

SUMMARY OF WORK.

3633.96 cubic yards rock, at \$1.55	\$5,632 64
4570.43 cubic yards brush, at 95 cents	3,884 86
	9,517 50
Retained percentage	951 75
	8,565 75
Survey, inspection, and office	1,165 19
	9,730 94

Much credit is due Mr. J. C. McElherne, inspector, for zealous and efficient service.

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

MAJ. A. MACKENZIE.

W 4.

CONSTRUCTING HARBORS OF REFUGE ON LAKE PEPIN AT STOCKHOLM, WISCONSIN, AND LAKE CITY, MINNESOTA.

The act passed August 2, 1882, made appropriation as follows:

Constructing harbors of refuge on Lake Pepin, twenty thousand dollars, of which sum ten thousand dollars at Stockholm, Wisconsin, and ten thousand dollars at Lake City, Minnesota.

The survey of proposed harbor sites was made in November and December, 1881, and the report and project rendered February 13, 1882 (see Report of Chief of Engineers, 1882, page 1795).

Estimates of cost were given for breakwaters at Lake City and Stockholm, as follows:

Lake City, 1,000 feet breakwater	\$154, 583
Lake City, 500 feet breakwater	53, 498
Stockholm, 1,000 feet breakwater	73, 370
Stockholm, 500 feet breakwater	34, 592

The amount appropriated, viz, \$10,000 for each locality, is too small to admit of beginning work according to the plans presented, and they must either be changed or the work be delayed until further appropriations are made sufficient to warrant commencement of operations.

My report and project for these works presented plans for piers, which would facilitate the landing of boats and shipment of freight. The cost of work given was the minimum with which any good results could be secured. Smaller amounts can be expended, but I should be unwilling to recommend such expenditures until an appropriation of the entire amount guarantees work which will benefit the interests of navigation.

As stated in my report, to secure the full benefits of harbors of refuge and protect the raft interest, the work suggested must be greatly extended.

As the act under which these examinations were made did not, as did act of August 2, 1882, call for or permit an expression of opinion as to the public necessity for this work, I contented myself with simply presenting in report, and attached letters and statistics, opinions of those practically engaged in navigation.

Should Congress deem it expedient on the evidence produced to continue appropriations for this work, it would, in my opinion, be desirable that an expression be given as to what appropriations may be expected in the future, and to the extent to which the work is eventually to be carried.

These works are located in exposed positions in deep water, and in case of failure of appropriations previous to completion to at least the extent contemplated in project presented, all work done previous to completion might be lost.

ABSTRACT OF APPROPRIATIONS.

By act passed August 2, 1882	\$20, 000
Of which \$10,000 for Stockholm, \$10,000 for Lake City.	

Money statement.

Amount appropriated by act passed August 2, 1882	\$20, 000 00
July 1, 1883, amount available	20, 000 00
Amount (estimated) required for completion of existing project	207, 953 00
Amount that can be profitably expended in fiscal year ending June 30, 1885:	207, 953 00

W 5.

COMPLETION OF WORK OF REMOVING SAND-BAR IN MISSISSIPPI RIVER
OPPOSITE GUTTENBERG, IOWA.

That part of the work performed prior to July 1, 1882, consisting of a closing dam in Swift Slough, is described in Report of Chief of Engineers, 1882, page 1767.

Soon after the construction of the closing dam in Swift Slough a strong current developed in Guttenberg Channel, and the shore of the island opposite Guttenberg, beginning at its head and extending down about 1,600 feet, began to be rapidly abraded. Fearing that deposits from this source would destroy the good effect already caused by the closing dam, it was decided to expend the balance of the appropriation in protecting this piece of caving bank. The *J. G. Parke*, with fleet of seven barges, together with the *Barnard* as a quarter-boat and coal-tender, commenced operations October 8, and completed same October 24, 1882.

Work was much interfered with by rains and wind storms.

Shore protection was built for a length of 1,520 feet.

Rock put in, 1,930.33 cubic yards.

Brush put in, 1,573 cubic yards.

The rock was taken from store at Glen Haven; the brush was cut by hired labor.

A great improvement in the crossing opposite Guttenberg, which was formerly the worst in the chute, was noticed.

As present plans do not contemplate any further work in this channel no additional appropriation is asked for.

If any emergency arises for protecting work already put in the same can be provided for from the general appropriation.

ABSTRACT OF APPROPRIATIONS.

By allotment of act approved June 14, 1880	\$3,000
By act approved March 3, 1881	5,000
	<hr/> 8,000

Money statement.

July 1, 1882, amount available	\$2,527 28
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	2,527 28

W 6.

REMOVAL OF BAR IN THE MISSISSIPPI RIVER OPPOSITE DUBUQUE, IOWA.

A small amount of dredging was done by Whitney & Son on Dunleith Bar early in the season of 1882, which work is described in Report of Chief of Engineers, 1882, page 1768.

A survey of the bars was made in November, 1882, by Inspector C. H. Benck.

Although the main bar has changed somewhat in the past few years, there has been no serious alteration for the worse.

The balance now available will probably be sufficient to carry on such work in connection with the removal of the Dubuque Bars as may be necessary during the fiscal year ending June 30, 1885, and therefore nothing is asked for under this appropriation.

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ABSTRACT OF APPROPRIATIONS.

By act approved August 14, 1876	\$15,000
By act approved June 18, 1878	10,000
By act approved March 3, 1879	4,000
By act approved June 14, 1880	7,000
By act approved March 3, 1881	5,000
	<hr/>
	41,000

There passed Dubuque Bridge during season of 1882, 4,345 steamboats, 822 barges, and 1,022 rafts.

COMMERCIAL STATISTICS OF THE CITY OF DUBUQUE FOR 1882.

Receipts by river:

Merchandise, miscellaneous	pounds..	260,000,000
Logs and lumber	feet..	141,400,000
Oats	pounds..	22,941,000
Barley	do..	3,224,000
Salt and cement	barrels..	20,200
Lead	pounds..	250,000
Flour	barrels..	12,000
Coal	pounds..	35,430,000

Shipments by river:

Merchandise, miscellaneous	pounds..	19,950,000
Oats	do..	90,000,000
Barley	do..	26,540,000
Iron and wagon stock	do..	750,000
Plows	number..	6,000
Cultivators	do..	1,200

Money statement.

July 1, 1882, amount available	\$10,755 10
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	380 78
	<hr/>
July 1, 1883, amount available	10,374 32
	<hr/>
Amount (estimated) required for completion of existing project	9,770 03

W 7.

ICE HARBOR AT DUBUQUE, IOWA.

The project for this work was submitted December 31, 1880. It proposes to deepen and enlarge by dredging Waples Cut, a basin which has been for years used as a winter harbor by steamboats and barges.

The total area which is to be utilized for a harbor is 502,500 square feet, and the grade of excavation 6 feet below low water of 1864.

Under appropriation of \$20,000, made by act passed August 2, 1882, proposals were called for, and the contract was let October 10 to Bart. E. Linehan, of Dubuque, the lowest bidder, at 19½ cents per cubic yard.

Owing, first, to delays experienced by contractor in securing proper machinery, &c., for his dredge, and, later, to the burning of the dredge itself, no work was done in 1882.

Soon after the contract was let a controversy arose in regard to the ownership of the land included in the proposed harbor limits, and the title of a large portion of it was found to lie in private parties.

The difficulty was settled by the city of Dubuque obtaining title to all the property required, empowering the United States to improve and maintain the premises for an ice harbor, &c., and guaranteeing police regulations and municipal control.

In order to ascertain the exact condition of the harbor site, and to mark out definitely the harbor lines, &c., an accurate detailed survey of the locality was made in November, 1882, and it was found, on a study of the map of the survey, advisable to change slightly the location of the harbor, as by so doing a larger area could be made available, and at a less cost than was at first estimated.

The contractor begun operations with two dredges April 21, 1883, and continued without intermission to the end of the year.

Some trouble was found in reaching grade during the high water in May, but this was compensated for by the shortness of tow, it being possible to dump the material on adjacent lowlands then covered with several feet of water.

Dredging operations were in charge of Inspector C. H. Benck, who proved very efficient.

SUMMARY OF WORK.

55,733.3 cubic yards material dredged, at 19½ cents.....	\$11,076 99
Engineering, inspection, &c	1,082 33
Total.....	12,159 32

ABSTRACT OF APPROPRIATIONS.

By act passed August 2, 1882	\$20,000
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Money statement.

Amount appropriated by act passed August 2, 1882.....	\$20,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$11,051 62
July 1, 1883, outstanding liabilities.....	1,107 70
	12,159 32
July 1, 1883, amount available	7,840 68
Amount (estimated) required for completion of existing project.....	20,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	20,000 00

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, Rock Island, Ill., at 2 p. m., September 23, 1882, for dredging at Dubuque, Iowa.

No.	Names and residences of bidders.	Dredging 80,000 cubic yards.	Aggregate.
		<i>Per cubic yard.</i>	
1	H. S. Brown, Quincy, Ill.....	\$0 23	\$18,400
2	H. Fox & Co., Chicago, Ill.....	24	19,200
3	B. E. Linehan, Dubuque, Iowa.....	19½	15,900
4	A. J. Whitney, Keokuk, Iowa.....	22	17,600

Contract awarded to B. E. Linehan.

W 8.

IMPROVEMENT OF ROCK ISLAND RAPIDS, MISSISSIPPI RIVER.

The main work of past season has been the maintaining of buoys and channel marks.

In August, 1882, twenty-three buoys were placed on the rapids. In November, when the buoys were taken up, nineteen were found, four having been carried away by rafts.

In April, 1883, sixteen buoys were located; the others will be put out when the stage of water permits.

The color of buoys has been changed this season from white to black, at the request of the pilots.

The system of buoys, though not yet as perfect as is hoped it will be made, has been greatly appreciated by the river men, and it should be maintained. The balance on hand at the present time will maintain the buoys during next fiscal year, but after June 30, 1884, no funds will be available unless a new appropriation is made.

In December, 1881, a survey of Duck Creek Chain was made, and some ledges of rock above grade discovered; a further survey was made last spring and estimates prepared of the amount of rock which should be removed.

The cut through this chain was made in 1867, and it is supposed an erroneous low-water mark was adopted.

To bring the bottom of this cut to a uniform grade of 4 feet below low water of 1864 will require the removal of about 1,000 cubic yards of rock, which, at \$8 per yard, will cost \$8,000.

With the removal of the rock at Duck Creek Chain it is supposed the improvement of Rock Island Rapids will be completed in accordance with original plan, which provides for a channel 200 feet wide and 4 feet deep at low water. As has been stated in previous reports, the channel should be widened to 400 feet, and the depth should be increased to 6 feet at low water.

Experience has shown that to preserve uninterrupted navigation on the rapids constant care and watching is necessary.

The buoys marking the channel are liable to be carried away, and must be replaced. Loose rock, snags, and bowlders are brought into the cuts by ice and current. In the open river such obstructions may interfere with navigation, but in the cuts on the rapids such obstructions, if they are not removed by natural or other causes, might at an extremely low stage completely block the channel.

To provide for the care of the rapids the work should be placed on the same basis as the Government canal at Keokuk. The annual cost of care, watching, surveys, &c., if no other work of improvements were going on, would be about \$5,000 per year, but if other work was being done the cost would be reduced to half this sum. To provide for removal of rock at Duck Creek Chain, and maintenance of buoys, and preserving a channel on the rapids, I submit an estimate of \$13,000.

For details concerning the work of past season I would refer to the report of Assistant Engineer E. F. Hoffmann, which is appended.

ABSTRACT OF APPROPRIATIONS.

By act approved June 23, 1866.....	\$100,000
By act approved March 2, 1867.....	200,000
By allotment from appropriation July 25, 1868.....	156,000
By allotment from appropriation April 10, 1869.....	133,650
By act approved July 11, 1870.....	150,000
By act approved March 3, 1871.....	150,000
By act approved June 10, 1872.....	50,000
By act approved March 3, 1873.....	50,000
By act approved June 23, 1874.....	50,000
By act approved March 3, 1875.....	50,000
By act approved August 14, 1876.....	25,000
By act approved June 18, 1878.....	30,000
By act approved March 3, 1879.....	6,000
By act approved June 14, 1880.....	8,000
By act approved March 3, 1881.....	8,000

Total..... 1,166,650

Money statement.

July 1, 1882, amount available.....	\$4,990 83
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	2,836 04
July 1, 1883, amount available.....	2,154 19
Amount that can be profitably expended in fiscal year ending June 30, 1885.	13,000 00

REPORT OF MR. E. F. HOFFMANN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 2, 1883.

MAJOR: I have the honor to present my annual report on the "Improvement of Rock Island Rapids, Mississippi River," for the fiscal year ending June 30, 1883.

OPERATIONS IN 1882.

The stage of the river in July being too high, no actual field work was done. The crew of the steam launch Lucia was employed in helping to construct two pile-drivers.

During August the Lucia towed the steam drill-boat and a small quarter boat to the head of the rapids, and proceeded to place the buoys. Twenty-three buoys were attached to ring-bolts inserted in the rocky bottom of the river bed. Of the old ring-bolts of the year 1881 only three could be found; generally, either the chain connecting the buoy with the ring-bolt had been carried off by anchor ice, or the sand had covered the chains to such a depth that the man with the searching grapple-iron could not reach them.

During September and October a couple of men were engaged in watching the buoys and regulating the length of the chain between the buoy and the ring-bolt.

In November the United States steamer Lucia was sent up the rapids with a small party for the purpose of taking the buoys up and storing them for the winter.

Nineteen buoys were found and taken up; the remaining four had been carried away by rafts.

After the river was closed by ice, the machinist was employed in overhauling and repairing the machinery of the Lucia and steam-drill.

OPERATIONS IN 1883.

1. *Surveys.*—A careful hydrographic survey was made early in the spring at Duck Creek Chain for the purpose of ascertaining the truth of the assertions of many pilots who claim the bottom of the cut is not at all points down to grade of 4 feet below low water of 1864. The work of excavation was done by means of a coffer-dam in 1867.

It may be said that the cut at Duck Creek chain was the first work executed at the rapids, and that a low-water mark shown by a Mr. Britton to Col. P. C. Hains, Corps of Engineers, at that time in local charge of the rapids improvement, must have been erroneously given.

The survey shows that some ledges of rock remain, which at a low stage of water obstruct navigation quite seriously. An estimate based on the hydrographic survey shows that about 740 cubic yards must be taken out to lower the cut to grade; to this must be added 260 cubic yards, which is about the proportional amount of unavailable excavation below grade.

The best method of removing the obstructing points will be to use a chisel-boat to break up the rock and then remove the broken rock with a dredge.

Coffer-dams or steam-drills cannot be used economically as the small quantity of rock is scattered over a very large surface.

This work can be accomplished in one season and at an average cost of \$8 per cubic yard.

ESTIMATE.

For removing rock at Duck Creek Chain by means of chisel and dredge, 1,000 yards at \$8 per yard, \$8,000.

2. *Placing buoys.*—The steam launch Lucia and steam-drill were used in placing sixteen buoys between April 20 and 25. Owing to the high stage of the water (12 feet above low water of 1864), and severe winds much trouble was experienced in grap-

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pling the chains. In some places, especially at Campbell's, the buoy chains appeared to be covered with sand.

In such places new chains could not be put in, owing partly to the high water, but principally to the fact that the holes for the ring-bolts would fill with sand directly upon withdrawing the drill, rendering it impossible to insert the bolt.

The lines fastened to the chains at the time of taking in the buoys in the fall of 1882 greatly reduced the difficulty in grappling the chains, as did also the ranges marked on the shore.

Sixteen buoys were placed, all but three of which are made fast to the old chains. The remainder of the buoys will be set out as soon as the river subsides sufficiently. On request of rapids pilots the color of the buoys was changed from white to black.

The system of buoys is appreciated by river men, and should be maintained.

3. *In general.*—When the work at Duck Creek Chain is completed, the improvement of the rapids may be said to be finished in accordance with the original plans, which proposed a channel width of not less than 200 feet with a minimum depth of 4 feet below low water of 1864.

Care will be required, however, to keep the channel free from obstructions such as loose rock, boulders, snags, &c., which are frequently brought into the cuts by ice and the rapid current, and which endanger and obstruct navigation.

The system of buoys designed to mark the crooked channel, any one of which is liable to be carried away by a passing raft, should be continually watched and taken care of, taken up and stored in winter, and replaced in the spring.

For the above-mentioned purposes a steam-launch 47 feet long and 8 feet beam was built in 1880.

To provide for the care of the buoys and free the cuts through the various chains from the constantly-recurring obstructions, it would, in my opinion, be wise for Congress to make an appropriation independent of the river and harbor bill, and similar in its provisions to those made for the care and operating of the Louisville and Des Moines Rapids Canal.

The Government has conferred a great boon on the people of the Mississippi Valley by improving the rapids, and it would seem wise to secure the benefits by using proper care.

I submit below an estimate in detail of the probable amount of money necessary annually:

Estimate.	Pay per month.	Pay for the year.
1. Under the direction of the engineer officer, United States Army, in charge of the improvement of the Upper Mississippi River, there should be an inspector or assistant engineer, who should reside at the rapids and have local charge of the work. He should keep the general office informed of all work, accidents to steamers, &c. The pay of such an inspector or assistant engineer to be	\$150	\$1,800
2. A pilot for the United States steam-launch from March 15 to November 15, eight months	60	480
3. A steam engineer, to be employed from March 15 to November 15, eight months. He also would perform duties on the steam-drill	60	480
4. A fireman to be employed from March 15 to November 15, eight months, at a rate of	50	400
5. A watchman to be employed from November 15 to March 15 of the following year, or during four months, at a rate of	45	180
6. Six laborers to assist in placing and taking up buoys and in replacing displaced ones, for, say, two months each, being twelve months, at	50	600
7. For fuel, coal and wood, during probably four months, actual work of steam-launch and steam-drill, per day \$4, or per month	120	480
8. For repairs to launch, steam-drill, quarter-boat, skiffs, &c., during the year		220
9. For purchase of ring-bolts, chains, material for buoys, as well as for dynamite or powder		250
10. For the probable employment of a dredge, during a time of ten days per year, for the purpose of removing obstructions such as detached rock, bowlders, or snags, at a cost of \$50 per day		500
Total		5,450

The above exhibit will be about the yearly average amount required for the preservation of the Rock Island Rapids.

Very respectfully, your obedient servant,

E. F. HOFFMANN,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

W 9.

IMPROVEMENT OF HARBOR AT ROCK ISLAND, ILLINOIS.

No project was made for the expenditure of the balance (\$6,669.02) available on July 1, 1882, the bar being in good condition at the time, and the dredges being in greater demand at other points.

An examination of the harbor will be made at an early day with a view to ascertaining its condition and presenting a project for further improvement.

No further amount is asked for for fiscal year ending June 30, 1885.

ABSTRACT OF APPROPRIATIONS.

By act approved June 14, 1886.....	\$6,000
By act approved March 3, 1881.....	6,000
	<hr/> 12,000

Money statement.

July 1, 1882, amount available	\$6,669 62
July 1, 1883, amount available	6,669 62
Amount (estimated) required for completion of existing project.....	14,759 15

W 10.

IMPROVEMENT OF THE MISSISSIPPI RIVER AT ANDALUSIA, ILLINOIS.

At the time of my last annual report the work accomplished consisted in the protection of the head of Island 321 and construction of Dam No. 2 between Islands 319 and 320.

To complete the project will require the building of Dam No. 1, extending from Illinois shore to Island 321, and Dam No. 3, between Islands 318 and 319.

As no money was appropriated for the purpose in the act passed August 2, 1882, and as the balance available July 1, 1882, was too small for operations in the field, no work was done.

The appropriation bore during the year its quota of office expenses and contingencies.

ABSTRACT OF APPROPRIATIONS.

By act approved March 3, 1881.....	\$6,000
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Money statement.

July 1, 1882, amount available.....	\$575 79
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	575 79
Amount (estimated) required for completion of existing project	12,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	12,000 00

W 11.

IMPROVEMENT OF HARBOR AT MUSCATINE, IOWA.

Work heretofore done at this locality has consisted principally in dredging along the city wharf, and has been very successful in removing deposits of mud and sand, and in keeping the landing free from the

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same. The harbor being in good condition at the beginning of the year, no project for improvement was presented, and no money has been expended.

An examination will be made in the fall to ascertain the condition of the harbor with a view to next season's work.

ABSTRACT OF APPROPRIATIONS.

By act approved March 3, 1879	\$7,500
By act approved June 14, 1880	7,500
By act approved March 3, 1881	2,500
By act passed August 2, 1882	2,500
	<hr/> 20,000

To secure a reasonably permanent channel in front of the Muscatine wharf, the present channel east of Island No. 335 should be closed, throwing the main river along the Iowa shore. This work cannot be attempted, however, until such time as the channel may naturally seek the new direction.

There also exists rock in place above the city and along the wharf, but no urgent necessity has yet arisen for its removal.

As any work necessary can be provided for from the general appropriation and funds now available, no additional appropriation is asked for.

Money statement.

July 1, 1882, amount available	\$420 26
Amount appropriated by act passed August 2, 1882	2,500 00
	<hr/> 2,920 26
July 1, 1883, amount available	2,920 26

W 12.

IMPROVEMENT OF HARBOR AT FORT MADISON, IOWA.

It being found that the shore of Island 392, opposite Fort Madison, was cutting rapidly in consequence of the dam across Niota Chute, and that the main channel of the river was becoming fixed on this side to the great detriment of the interests of Fort Madison, it was determined to protect the shore along the head of 392, as also that of 393, and to lay a foundation for a dam across the chute from 392 to 393. The shore protection was constructed, but owing to cold weather setting in, operations ceased before the dam was begun.

The *Parke* with twelve barges, and *Barnard* (as quarter-boat and coal-tender) worked from November 2 to 15, 1882, inclusive.

The work accomplished consisted of 470 feet shore protection on Island 392, from 30 to 80 feet in width and very heavy; 680 feet on Island 393, and 170 feet on 392, at ends of proposed dam.

Total length of shore protection 1,320 feet.

	Cubic yards.
Rock put in	2,141
Brush put in	1,625
Total	<hr/> 3,766

The cost of putting in the material and cutting the brush was paid for from appropriation "Improvement Mississippi River, Saint Paul to Des Moines Rapids," but the rock was purchased from funds belonging to special appropriation for harbor at Fort Madison.

ABSTRACT OF APPROPRIATIONS.

By act approved August 14, 1876.....	\$10,000
By act approved June 18, 1878.....	8,000
By act approved March 3, 1879.....	3,600
By act approved March 3, 1881.....	2,500
Total.....	14,100

Money statement.

July 1, 1882, amount available.....	\$2,274 25
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	2,274 25
Amount (estimated) required for completion of existing project.....	6,086 87
Amount that can be profitably expended in fiscal year ending June 30, 1885.....	6,100 00

W 13.

IMPROVEMENT OF DES MOINES RAPIDS, MISSISSIPPI RIVER.

This work, which has for its object the improvement of navigation over the Des Moines Rapids, was commenced in 1866. The adopted plan contemplated the construction of a closed canal 8 miles in length, reaching from Keokuk to Nashville, and an open canal, cut through the rocky bed of the river, from Nashville to Montrose, a distance of 4 miles. The canal was so far completed in 1877 as to permit the passage of boats, and it was thrown open.

At that date there remained much work to be done to complete the improvement according to the original project, and since the canal has been in operation experience has shown the necessity for some additional work not at first contemplated.

It was perhaps unfortunate for this work that the canal was opened so soon, though the pressure naturally brought to bear by those interested in navigation was so great that it could not be resisted.

Had the opening of the canal been delayed a year or more, it is probable a sufficient appropriation would have been made to complete the original project; but the mere fact of the canal being used seemed to carry with it an impression that the work was completed, and subsequent appropriations have been so small as to greatly delay completion, and the effect of spreading the work over so many years has been to leave embankments in an unprotected condition and increase the cost; also to delay work of excavation and leave large deposits to accumulate in the canal.

An estimate is submitted with this report for completing the work in accordance with original project and for carrying out such additional work as experience has shown to be necessary. It would be greatly to the interest of the work if the amount desired could be given at once. It is hoped that after such an amount is given no further necessity will arise for recommending further appropriations under this head, and that thereafter provisions for all necessary repairs and improvements can be made from the indefinite appropriation which now provides for opera-

tion and care of canal. But still such a result cannot be guaranteed except at the expense of the cost of operating and care, for this cost is now based on ordinary expenses of the canal in its present condition, whereas extraordinary repairs are always liable to become necessary, and with time the ordinary repairs and expenses, other than that of operating force, will necessarily increase.

At the commencement of the fiscal year the work remaining to be done consisted in completing the protection of the canal embankment and the removal of rock from the open canal above Nashville, the construction of two additional cribs to facilitate and render more safe the upper entrance to the canal and the raising of the walls of the lower lock and middle lock. A detailed account of the portion of this work accomplished during the past year is given in the report of Mr. M. Meigs, United States civil engineer, who, during the past year, has had special charge of this work.

There had been expended on this work up to present date \$4,372,824.27, and for operating and care of canal, \$277,262.96.

The estimated cost of this work under existing project is \$4,492,680. This amount includes an item of \$41,745 added and fully explained in last year's report. There is now a balance on hand of \$23,110.73, and there is required to complete the work, as shown by figures given, \$96,745.

The good of the work requires that this amount should be appropriated, that arrangements may be made for completion within a reasonable time.

The Keokuk Bridge was located so close to the foot of the Des Moines Rapids and canal and built with so little regard to the interests of navigation that it is a source of danger to steamers descending the rapids. The bridge company might obviate a portion of the difficulty by extending the long pier of the bridge to a junction with the outer canal wall.

Money statement.

July 1, 1882, amount available	\$30,247 17
Amount appropriated by act passed August 2, 1882.....	30,000 00
	<hr/> 60,247 17
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	37,136 44
	<hr/> 23,110 73
July 1, 1883, amount available	23,110 73
Amount (estimated) required for completion of existing project.....	96,745 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	97,000 00

Abstract of proposals received and opened by Maj. A. Mackensie, Corps of Engineers, at Keokuk, Iowa, June 8, 1882, for furnishing stone for riprap face at Des Moines Rapids Canal, Mississippi River.

No.	Names and residences of bidders.	6,000 cubic yards stone.	Amount.
		<i>Per cu. yd.</i>	
1	Patterson Bros., Keokuk, Iowa*	\$3 00	\$18,000
2	Peterson & Schrader, Rock Island, Ill., and Glen Haven, Wis.	3 27½	19,650
3	Whitney & Son, Keokuk, Iowa.....	3 25	19,500
4	H. S. Brown, Quincy, Ill.	4 00	24,000

* Contract awarded.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 2, 1883.

MAJOR: I have the honor to present my report on the improvement of Des Moines Rapids, Mississippi River, for the fiscal year ending June 30, 1883.

RIPRAPING CANAL EMBANKMENT.

Patterson Brothers have completed their contract for delivering 6,000 cubic yards of riprap face stone, and the whole amount has been laid. The surface covered is a strip extending from 500 feet above the lower lock to near the middle lock, about 2 miles long and averaging 6 feet wide on the inside face of the canal bank, and various detached places on the outside of the embankment, principally between sections 7 and 19.

The outside slope wall along this whole section is now about 2 feet above high water of 1881, or about the height of the high water of 1857. By authority of the Chief of Engineers a new contract (informal) was made with Patterson Brothers for delivering 3,000 cubic yards of riprap stone to continue the work of protecting the outside of the embankment between the middle and lower locks. The following statement shows the amount of stone received and the areas laid. The riprap stone is for making a berme on the outside of the embankment from which to start the slope wall.

STATEMENT OF STONE RECEIVED AND WORK ACCOMPLISHED DURING THE FISCAL YEAR ENDING JUNE 30, 1883.

	Cubic yards.
Riprap face stone received (old contract)	6,000.00
Riprap face stone received (new contract)	692.53
Riprap stone received (new contract).....	1,776.80
Square yards wall laid	14,222.90

Under the old contract Patterson Brothers delivered the paving stone on the canal embankment at \$3 per cubic yard. By the new arrangement they deliver the stone on United States barges at the quarry at \$2.40 per cubic yard, and the United States delivers it at the canal. This effects a saving of about 25 cents per yard, delivered.

RAISING LOCK WALLS—LOWER LOCK.

This work was begun in September, 1882. The gap in the low wall below the lock was filled level with the coping at the foot of the stairs, and the whole wall strengthened by adding to its thickness at the back. This was accomplished with a good deal of difficulty, owing to the leaks which showed themselves and made expensive draining necessary.

The wall is now at its base 10 feet thick, and ready when the water falls to be carried up to the full height, 4 feet above the present coping of the lock walls.

The face stone and backing are both furnished from the Sonora quarry, by Patterson Brothers, who have furnished most of the stone used of late years on the canal. The prices are the same as for the guard lock: face stone, \$13 per cubic yard; backing stone, \$7.

There has been delivered up to June 30, 1883:

Face stone	cubic yards..	79.29
Backing stone	do.....	134.74
Cement	barrels..	82

DREDGING ROCK FROM CHANNEL ABOVE NASHVILLE.

During the year a considerable amount of rock has been taken out, principally at the head of Montrose Chain. The excavation of blasted material is nearly complete at this place, but a sand-bar has so covered the bed of the river that constant sand dredging has been necessary in order to keep a navigable channel open. There were taken out 1,529.9 yards, of which in the vicinity of Nashville 1,290, and at Nashville Dam No. 2, 234.6 cubic yards. In addition to the rock excavation there were 16,643 cubic yards sand removed, the expense being borne by the appropriation for operating and care of canal.

There is still a patch of rock above Nashville coffer-dam No. 2 which badly needs dredging, but there is a narrow channel of sufficient depth past it, and the dredge has been occupied so busily in other places that it has been impossible to get at the work until now. Buoys were set out in June, 1883, to make the passage of this rock pile easier, and early in the summer it is thought the dredge can be put at this work and kept on it until completed.

1416 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

REPAIRING CRIBS FOR CHANNEL GUIDES BETWEEN MONTROSE AND NASHVILLE.

A small force of carpenters was set at work in September to make needed repairs on the piers or beacons along the right-hand side of the channel above Nashville. Three of these were repaired, newly covered with iron plate, and the iron painted. In future it seems as if these repairs should be paid out of operating and care of canal allotments.

In this work, as well as in operating canal and the dry dock, I have been assisted by Overseer C. M. Bennett and Clerk F. J. Warren, who deserve credit for the manner in which they performed their varied duties.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

Quarterly money statement of the Des Moines Rapids Canal for the fiscal year ending June 30, 1883.

Quarters.	Allotment, operation for and care.	Appropriated for improvement.	Appropriated for dry dock.
Third quarter, 1882.....	\$28,919 81	\$7,664 90	.....
Fourth quarter, 1882.....	25,425 57	15,594 14	.....
First quarter, 1883.....	9,979 91	2,566 09	.....
Second quarter, 1883.....	13,602 00	11,291 31	\$5,392 95
Actual expenses for year ending June 30, 1883, above less outstanding liabilities reported July 1, 1883.	77,926 79 8,288 48	37,136 44	5,392 95
Actual expenses	69,638 31	37,136 44	5,392 95

M. MEIGS.

KEOKUK, IOWA, July 10, 1883.

W 14.

OPERATING AND CARE OF DES MOINES RAPIDS CANAL.

During the past fiscal year the canal has been open to navigation two hundred and twenty-seven days; it was closed by ice November 25, 1882, and opened April 13, 1883. The long periods of high water have permitted many boats to pass the rapids thereby reducing the traffic statement. There have passed through the canal 1,107 steamboats and 705 barges carrying 9,192 passengers, 43,359 tons of general merchandise, and 729,174 bushels of grain; also rafts containing 13,093,325 feet of lumber and 1,040,000 feet of logs, and carrying 4,435,000 shingles and 11,558,000 lath. There have been made at the middle locks, 1,353 lockages.

A force has been constantly employed repairing the canal embankment, portions of which, originally built by contract, have been and still are in poor condition due to unavoidable delays in protecting by paving, and to large quantities of rock which found their way into the embankment when it was originally built. Many leaks have developed themselves, and in the spring when the river was backed up by an ice-gorge the embankment was for a short time in great danger. The natural soil, which underlies portions of the embankment is also in such a condition as renders the permanency of the embankment doubtful, unless extensively repaired. The repairing and securing of this embankment will prove a constant source of expense to the appropriation for operating and care for some time to come, and this item is one which has been necessarily increased since estimates were made for the expenses of maintaining the canal.

Dredging was continued in the canal by aid of one Government dredge, and, under contract with Whitney & Son, 124,402.6 cubic yards were dredged, of which amount over 100,000 were removed from the canal. A large amount of material which is the accumulation of years still remains to be removed, and each freshet brings in a fresh supply. No provision has been made, though, for any new dredging contracts during the coming year, it being believed the Government dredges can keep such a channel open as will satisfy the needs of navigation. This dredging will always be a source of expense, but it is hoped the cost can be reduced as soon as the old accumulations are gotten rid of.

A new source of expense developed itself during the past year. The sand-bars lying in the river above the cut at Montrose moved down and threatened to close the only low-water channel; dredging at this point has been kept up all the season, 16,643 yards of sand and 1,290 yards of rock being removed. This dredging must be continued so long as the sand continues to move down and obstruct the channel. To partially obviate the trouble, a dam running up-stream from the rock pile marking entrance to cut was constructed, and a closing dam from an island opposite Montrose to the Illinois shore was commenced. The expense of the latter dam was paid for from the appropriation for "Improving Mississippi River, Saint Paul to Des Moines Rapids," but as the object of the work is to restore the artificial channel of open canal to its original condition, any further expense in connection with the work would seem to be a fair charge against the appropriation for "operating and care of Des Moines Rapids Canal."

To facilitate repairs and reduce expenses by utilizing the labor of certain canal employes during the time when canal was closed, a machine shop was established last year at the lower lock of canal. This has proved of great value, not only in connection with the repairs of canal plant and machinery, but also in connection with the repairs of the various plants employed on general river improvement. While the actual saving in cost of repairs is considerable, the greatest benefit which arises from the canal shop is the avoidance of delays which must always be expected when dependence for repair work is placed on private machine shops.

Further details concerning the work of past year are found in the appended report of Mr. M. Meigs, United States civil engineer, who has had the management of the canal, in addition to the immediate charge of the improvement of the Des Moines Rapids and the construction of the dry dock. Much credit is due Mr. Meigs for his work, which has not only been in the interest of the Government, but in the interest, as well of those for whose use the canal was constructed.

The estimate for the annual expense of "operating and care of Des Moines Rapids Canal" presented by Colonel Macomb and Major Stickney, was \$40,000, and this amount is ample for what may be termed ordinary expenses. But this estimate made no allowance for work above the guard lock, as the necessity for such work was not and could not well be anticipated; neither did it make any allowance for the extensive repairs to embankment which it was naturally supposed was well built and would be immediately finished and properly protected. On the supposition that the indefinite appropriation is intended to keep the canal, including the open channel above the guard lock, open to navigation and to restore to its original condition such parts as have been injured since completion in accordance with original project, it will be necessary to increase annual expenditures for a few years to come.

1418 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

If all parts of the canal are once placed in good condition the operating expenses can be sufficiently reduced below the original estimates to provide a fund for extraordinary repairs, such as rebuilding gates, replacing worn-out machinery, &c.

It is hoped that authority will be granted to light the lower locks with electricity; this would greatly facilitate night work and render safer the passage of the bridge just below the lock. There has been expended in connection with operating and care of canal since it was opened, in 1877, \$277,262.96; of this amount \$117,500 was specially appropriated; \$40,065 was allotted from the appropriation for improvement, and \$119,697.96 from the indefinite appropriation.

There has been expended during the fiscal year ending June 30, 1883, on account of operating and care of canal, \$77,926.79; this amount includes \$8,288.48 outstanding at beginning of the year, leaving \$69,638.31 as actual expenses; of this amount \$28,456 was paid for extraordinary dredging and \$2,918.66 was paid for construction of a coffer-dam, rendered necessary by a breakage to gates of guard lock; deducting these amounts reduces the operating expenses to the sum of \$38,263.65.

It is estimated that \$49,500 will be required for operating and care during the coming fiscal year; this estimate includes items of extraordinary expense of \$8,000 for dredging at the head of the cut through Montrose Chain and \$1,500 for lighting lower locks by electricity; it also includes items of \$4,900 for repairing the canal embankment, and \$6,700 for continuing the removal of accumulated deposits from the canal. If these amounts could be deducted, the expenses of operating would be reduced to \$28,400. The expense attending repair of embankment will be very materially reduced, if not done away with, as soon as the appropriations for completing improvement of Des Moines Rapids permit the proper protection of the bank, and the expense of dredging will be gradually reduced.

The strictest economy will be exercised in connection with the management of the canal under the indefinite and unlimited appropriation which Congress has made for this work, and no expenditures will be recommended or made which are not strictly in the interest of navigation, and necessary for preserving uninterrupted travel through the canal and open channel above the guard lock. But it must be remembered that the canal, though in use for several years, has never been completed in accordance with original project, and the present expenses connected with operation and care cannot be considered as a guide to what the same expense will be when all parts are placed in a completed condition. It must be further considered that the canal is made up of many parts, any one of which is liable to get out of order, and by so doing to entirely interrupt navigation. The indefinite appropriation being made to prevent this must cover more work than would be included in what would, at first thought, be considered ordinary expenses of operating and care.

Money statement.

July 1, 1882, cash balance.....	\$3,228 83
Amount received from Treasury during year ending June 30, 1883.	75,000 00
	<hr/>
	78,228 83
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$69,638 31
July 1, 1882, outstanding liabilities.....	8,288 48
	<hr/>
	77,926 79
July 1, 1883, amount available	<hr/>
	302 04
Amount that can be profitably expended in fiscal year ending June 30, 1885.	<hr/>
	49,500 00

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Keokuk, Iowa, on June 8, 1882, for dredging in Des Moines Rapids Canal.

No.	Names and residences of bidders.	100,000 cubic yards of material, per cubic yard.	Amount.
		<i>Cents.</i>	
1	Whitney & Son, Keokuk, Iowa*	294	\$29,750
2	H. S. Brown & Co., Quincy, Ill.	30	30,000

*Contract awarded.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 2, 1882.

MAJOR: I have the honor to submit the following report on operating and care of the Des Moines Rapids Canal for the fiscal year ending June 30, 1883.

There have been long continued periods of high water during the fiscal year ending June 30, 1883, and like the year that preceded it, the boats navigating the Mississippi have been able, very generally, to pass over the rapids. In consequence the traffic statement appears small, while in fact there seems to have been some increase in the river commerce.

The lower lock gates which are only thrown open to allow the free entry of the river at high water have stood open as follows:

	Days.
July 1-8, 1882.....	8
April 30 to May 25, 1883,.....	25
June 14-15.....	1
June 19-24.....	5
Total.....	39

The canal was closed to navigation November 25. Most of the boats had then laid up for the winter and ice had formed in the canal. The winter proved a severe one, and ice 19 to 20 inches thick formed in the canal making a fine ice harvest. The river broke up March 1, and the ice moved out at a very high stage of water. It injured considerably the slope wall on the outside of the canal, and cut into the embankment where it had no slope wall covering.

The canal was opened for navigation April 13, 1883, and has been in use during the past fiscal year two hundred and twenty-seven days.

The highest stage of water was reached May 18, 1883, when the stage was 15.45 feet above low water.

REFILLING AND REPAIRING THE CANAL EMBANKMENTS.

During most of the working season a force has been more or less steadily employed repairing the embankment, replacing the earth washed off from its unprotected slopes, and raising the low places where it had settled.

In the upper level the bank has been raised to grade from the middle lock to Rickey's Point.

Extensive repairs were made to the canal embankment at sections 25 and 26 near the middle lock.

Quite a break occurred at one time, but was quickly repaired necessitating, however, the partial drawing off of the water.

DREDGING IN THE CANAL.

Under contract with Messrs. Whitney & Son, of Keokuk, Iowa, for 100,000 cubic yards of dredging, dated June 9, 1882, a fleet of steam tow-boats, dredges, and dump-boats was employed from July 1 to November 18, when their contract was finished.

The work was all in the upper level of the canal and mostly in the vicinity of the three creeks discharging into the upper level, namely Price's, Ballinger's, and Lamallee's creeks.

1420 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

The total amount removed by Whitney & Son June 30, 1882, to November 18, 1883, was 90,857.6 cubic yards.

The United States dredge worked in the canal from July 1, 1882, to August 22, 1882, when she was removed to the channel at head of Montrose Chain. A sand bar had formed at this point filling the channel excavated in the rock and obstructing navigation.

It was only by constant dredging that this channel was kept open sufficiently to allow the passage of boats.

The following statement shows the work done by the United States dredge, June 30, 1882 to June 30, 1883:

	Cubic yards.
Sandusky.....	23, 421
Price's Creek.....	6, 676
Middle lock.....	328
Montrose, sand.....	16, 643
Montrose, rock.....	1, 290
Nashville, Dam 2, rock.....	235
Guard lock.....	3, 120
Grand total.....	51, 713

Of this amount about 20,000 cubic yards was only removed from the channel of the canal and dumped at the sides, there being no tow-boat available for towing into the river and the creeks at Price's and Sandusky having thrown down bars since the thorough dredging of last season which required removal.

The rock excavated at Montrose and Nashville belongs properly to the improvement of Des Moines Rapids and will be mentioned under the proper head. The following statement shows the amount of material removed from the canal up to June 30, 1883.

Table showing amount of material removed from the Des Moines Rapids Canal June 30, 1878, to June 30, 1883, or total to date.

Years.	United States dredge.	Teams.	Contract.	Total.
	Cubic yards.	Cubic yards.	Cubic yards.	Cubic yards.
Fiscal year ending June 30, 1879.....	8, 700			8, 700
Fiscal year ending June 30, 1880.....	26, 496	1, 288	11, 553	38, 936
Fiscal year ending June 30, 1881.....	9, 003			9, 003
Fiscal year ending June 30, 1882.....	18, 031		49, 758	67, 789
Fiscal year ending June 30, 1883.....	22, 717		90, 858	113, 575
Grand totals.....	84, 947	1, 288	152, 109	238, 403

The above does not include material dredged in the canal, but not towed out into the river (about 20,000 cubic yards), nor 16,000 cubic yards of sand removed from the channel at Montrose.

A good deal of the material removed during the thorough dredging of the past season, was accumulated in the canal before it was opened to navigation and while the building of the canal was in progress. Comparatively the canal is now in better condition, as regards available depth, than for many years past.

REPAIRING FLAT-BOATS, DREDGE, &C.

During the past year the boat-yard at Nashville has been kept busy repairing and rebuilding flat-boats, &c. During the past winter a new hull was built for tow-boat No. 4 and the boat rebuilt.

There was a new crane built for the dredge, and the blacksmith's barge was overhauled and a new end put in. A large number of barges were hauled out on the ways, repaired, and put in the water again; most of these belonged to the Upper Mississippi River improvement fleet.

REPAIRS TO LOCK MACHINERY.

Very considerable repairs have been made from time to time to the machinery for operating the gates, but has been done at trifling expense in the machine-shop belonging to the canal. Extraordinary repairs were necessary at the guard lock to replace the hoods on the opening and closing sheaves at the bottom of both upper and lower gates. This necessitated a coffer dam 12 feet high above the head of the canal,

and a small one across the foot of the lock. November 25 a coffer-dam was begun which, owing to the nature of the material used for filling it, soon collapsed, and cold weather setting in work had to be abandoned until spring.

A dam was successfully put in, the repairs made, and the dam removed again by April 13, 1883. The filling used in the second dam was taken from the old coffer-dam No. 1 above the guard lock.

At the guard lock most of the multiplying sheaves for half-inch wire rope were bushed with brass. New leathers were supplied to the hydraulic cylinders at each lock where they were needed.

MACHINE SHOP AT LOWER LOCK.

During the winter months four machinists and two carpenters belonging to the regular force were kept steadily at work making repairs. The usefulness and economy of the shop will be seen in the following exhibit of the first season's work. Accounts have been carefully kept to show the work accomplished, and the work done has been charged up to the proper appropriation in each case as directed in the letter of authority of the Chief of Engineers.

The prices charged for work have been the same, as nearly as possible, as prevail in other shops, so that the figures show what we would have paid for the same work if we had no shop belonging to the canal.

The exhibit shows the value of the labor performed by the regular canal employes, engineers, lockmasters, &c., who have always been retained the year round. The cost of the shop, purchase of tools, &c., has been about \$3,100, but many tools have been made in the shop itself, adding greatly to the value of the plant.

EXHIBIT SHOWING VALUE OF WORK DONE IN UNITED STATES REPAIR SHOPS AT LOWER LOCK, JUNE 30, 1882, TO JUNE 30, 1883, BY REGULAR EMPLOYÉS OF THE CANAL FORCE.

Appropriations, operating and care canal:

Lock repairs.....	\$224 05	
Rebuilding launch.....	1,744 72	
Machine shop, tools and implements.....	1,005 07	
United States dredge.....	587 24	
Canal embankment.....	1 60	
Miscellaneous.....	43 74	
		\$3,605 82

Appropriation improving Des Moines Rapids:

Raising lock walls, &c.....	100 30	
Building slope wall.....	4 00	
		104 30

Appropriation improving Mississippi River, Saint Paul to Des Moines Rapids:

Tow-boat No. 4.....	388 32	
Tow-boat No. 3.....	1 75	
		390 07

Appropriation improving Mississippi River, mouth of Illinois River to Des Moines Rapids:

Repairs to launch Irene.....	119 52	
Repairs to steamer Coal Bluff.....	75 75	
Building new dredge.....	46 15	
		241 42

Appropriation dry dock at Des Moines Rapids Canal:

Dump, cars, track, &c.....		197 70
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Appropriation improving Upper Mississippi River:

Steamer General Barnard.....	11 20	
Steamer J. G. Parke.....	16 25	
		27 45

Grand total..... 4,566 76

The principal items of work accomplished, it will be seen, consisted in the rebuilding of the canal launch into a larger and more powerful boat 60 feet long, 12 feet beam, with double engines 6 inches diameter and 30-inch stroke.

The dredge machinery was very thoroughly gone over and extensive repairs made. Tow-boat No. 4 was also overhauled and a great deal of work done on her machinery.

1422 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

BUSINESS OF THE CANAL.

Continued high water has made the showing of the canal a small one, as most of the commerce has gone outside. The following is the traffic statement:

Traffic statement of the Des Moines Rapids Canal, June 30, 1882, to June 30, 1883.

Months.	Steamboats.	Barges and flats.	Cargo.			Rafts.				
			Passengers.	General mer- chandise.	Grain.	Lumber.	Logs.	Shingles.	Lath.	Lockages at one foot.
	No.	No.	No.	Tons.	Bush.	Feet.	Feet.	No.	No.	No.
July	128	63	1,731	4,062	14,639	263,000				143
August	234	159	2,828	6,068	29,755					279
September	265	212	1,888	7,417	135,043	724,059	240,000	530,000	123,000	306
October	224	151	1,099	9,669	194,999	12,106,266	800,000	3,906,000	11,422,000	326
November	54	63	403	5,433	171,677					94
March										
April	73	48	294	4,924	65,731					74
May	51	4	196	1,472	53,837					18
June	78	6	773	4,314	63,993					118
Total	1,107	705	9,192	43,359	729,174	13,093,325	1,040,000	4,435,000	11,558,000	1,358

I desire to express my thanks to Mr. C. M. Bennett, assistant engineer; Mr. F. J. Warren, clerk, and to the other employes of the canal force, for faithful and intelligent assistance at all times.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

W 15.

DRY DOCK AT DES MOINES RAPIDS CANAL, MISSISSIPPI RIVER.

The act of Congress passed August 2, 1882, contained an item of \$30,000 for commencing the construction of a dry dock in connection with the Des Moines Rapids Canal.

A project submitted September 12, 1882, and approved February 10, 1883, provides for a dock 400 by 100 feet, with earthen embankments well protected by riprap and paving stone. The dock is located on the river side of the canal above the middle lock; the entrance is from the canal through gates of 80 feet, and drainage is provided for through a sluice in the outer embankment.

The cost of the dock is estimated at \$125,000.

High water has delayed work, but material has been collected, and when the water falls work will be rapidly carried on. Details as to work done during the year is given in appended report of Mr. M. Meigs, United States civil engineer.

A special report on this dry dock was made, and is printed as House Ex. Doc. No. 179, Forty-seventh Congress, first session.

ABSTRACT OF APPROPRIATIONS.

By act passed August 2, 1882 \$30,000

Money statement.

Amount appropriated by act passed August 2, 1882.....	\$30,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1883	5,392 95
July 1, 1883, amount available.....	24,607 05
Amount (estimated) required for completion of existing project.....	95,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	95,000 00

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 2, 1883.

MAJOR: I have the honor to submit the following report on dry dock at the Des Moines Rapids Canal, Iowa and Illinois, for fiscal year ending June 30, 1883:

By act of Congress of August 2, 1882, \$30,000 was appropriated for beginning the construction of this dry dock. The dry-dock chamber is to be 100 by 400 feet, and capable of accommodating the largest steamers afloat on the Upper Mississippi River.

The outer wall of the dry dock will be of earth and will inclose a piece of land located outside the middle lock. A pair of gates with opening of 80 feet will give admission to boats, and a sluice will serve to empty the basin of water in a few minutes.

Authority was granted to begin work, by letter of the Chief of Engineers, dated February 10, 1883, purchase in open market and day labor being preferred, owing to the spongy and treacherous nature of the soil on the site of the dry dock.

Preparations have been made to push the work with rapidity as soon as the water in the river falls sufficiently.

A barrow pit or clay quarry has been selected and a track built to it from the canal some 800 feet distant. Two barges have been fitted up for transferring the cars across the canal and the two landing docks built.

Two thousand nine hundred and seventy-two cubic yards of riprap stone were bought of Patterson Brothers, and delivered along the outside edge of the dry dock for protection of the earth embankment when finished.

The high stage of water was of great assistance in delivering this stone and enabled it to be put very nearly in place when thrown off the barges, greatly lessening the cost of this item.

There were in addition 232 cubic yards of riprap face stone unloaded so as to be ready to protect the bank the moment it is finished sufficiently.

A contract for 3,000 cubic yards is in force, and this stone will probably be delivered before the season closes. Messrs. Patterson Brothers furnish the stone; riprap at 75 cents and slope-wall stone at \$2.40, on barges at the quarry.

A set of dump-cars has been built from the remains of old cars in use formerly on the canal. The use of all this old plant has allowed a great saving in the cost of the work.

DITCHING.

A number of long and deep ditches have been dug for draining the site of the dock and collecting the seepage water, so as to allow of the soil drying out preparatory to excavation.

It is foreseen that very considerable additional expense in constructing the dry dock will result from the leaky nature of the present canal embankment over a greater part of the length inclosed in the dry-dock site.

SURVEYS.

Numerous surveys and maps have been made of the dry-dock site, and borings to determine the position of the rock underlying it.

Mr. C. M. Bennett acted as assistant on this work, and performed his duties efficiently and well.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

W 16.

IMPROVEMENT OF THE MISSISSIPPI RIVER AT AND NEAR THE CITY OF ALEXANDRIA, MISSOURI.

No funds were appropriated for this work by act passed August 2, 1882, and the small balance available July 1, 1882, was expended in defraying office expenses properly chargeable to the work.

The work already constructed, consisting of two wing-dams, extending from the Missouri shore, has proved very successful, and it is not believed that further funds will be needed other than those that may be applied from time to time from the general appropriation "from Des Moines Rapids to Illinois River" in keeping in repair the works now built.

ABSTRACT OF APPROPRIATIONS.

By act approved June 14, 1880.....	\$10,000
By act approved March 3, 1881.....	6,000
Total	16,000

Money statement.

July 1, 1882, amount available.....	\$210 06
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	210 06
Amount (estimated) required for completion of existing project.....	14,945 75

W 17.

IMPROVEMENT OF THE MISSISSIPPI RIVER AT QUINCY, ILLINOIS.

The effect of the works constructed in 1879 having proved so beneficial to the navigation of the river in this locality, it was thought best to withhold the project for the expenditure of the balance available July 1, 1882, until later, in order to study thoroughly the movement of the bars and plan additional works for securing the improvement already obtained.

A survey will be made in the fall of this year, from the notes of which data will be gained for projecting work for next season.

ABSTRACT OF APPROPRIATIONS.

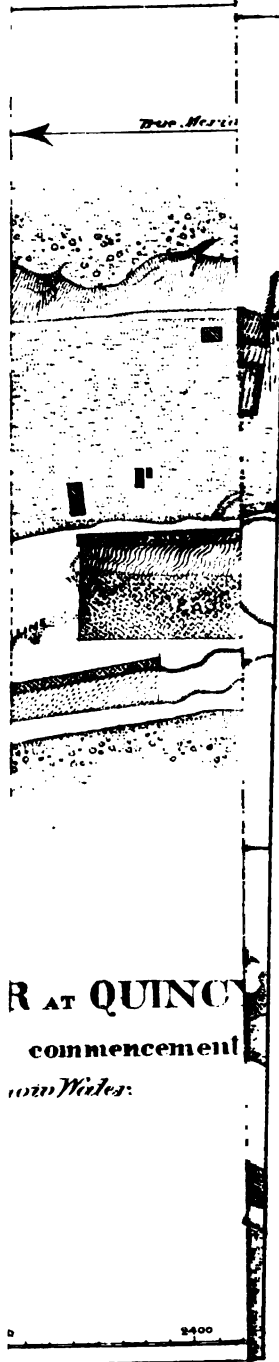
* By act approved March 3, 1879	\$20,000
* By act approved June 14, 1880	25,000
	45,000

No further appropriation is asked for.

Money statement.

July 1, 1882, amount available.....	\$12,526 22
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	35 00
July 1, 1883, amount available	12,491 22

* \$10,000 allotted for dredging in Quincy Bay.



W 18.

IMPROVEMENT OF QUINCY BAY, ILLINOIS.

The project for this work is given in report of Chief of Engineers for 1879, page 1130.

The act passed August 2, 1882, appropriated \$15,000 for improvement of Quincy Bay. It was proposed to continue dredging on the bars above the railroad bridge and at the entrance to the bay.

The work was carried out under contract with H. S. Brown, of Quincy.

Although a large sum of money has been expended in improving Quincy Bay most of the property bordering the bay is held by private parties, and no provisions have yet been made for furnishing suitable grounds for tying up boats and fleets belong to the general public.

Before any further work is done some arrangements should be made which will secure to the general interests of navigation the good which is expected to be accomplished by the establishment of a safe winter harbor.

A portion of the island opposite Quincy was deeded to the United States by the city as a harbor for the Government fleets working on the lower portion of the Upper Mississippi. This property has not yet been accepted by Congress, and no work has yet been done towards making it a suitable harbor. It is proposed though during the present season to drive sufficient piling along the shore to render secure such portions of the Government fleet as may be wintered in Quincy Bay.

Details of the work are given in accompanying report of Assistant Engineer C. W. Durham.

ABSTRACT OF APPROPRIATIONS.

By act approved March 3, 1881.....	\$10,000
By act passed August 2, 1882	15,000
	<hr/> 25,000

NOTE.—\$20,000 additional, allotted from appropriation for "Improving navigation of Mississippi River at Quincy, Ill.," has been used in the improvement.

Money statement.

Amount appropriated by act passed August 2, 1882.....	\$15,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	14,797 89
	<hr/> 202 11
July 1, 1883, amount available	
Amount (estimated) required for completion of existing project.....	154,109 87
Amount that can be profitably expended in fiscal year ending June 30, 1885.	50,000 00

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, Rock Island, Ill., at 2 p. m., September 23, 1883, for dredging Quincy Bay, Illinois.

No.	Names and residences of bidders.	Price for dredging.		Aggregate.
		Towing 1 mile.	Towing 2 miles.	
		<i>Per cu. yd.</i>	<i>Per cu. yd.</i>	
1	H. Fox & Co., Chicago, Ill	\$0 21	\$0 23	\$0 44
2	H. S. Brown, Quincy, Ill *	20	22	42
3	A. J. Whitney, Keokuk, Iowa	21½	23½	45
4	B. E. Linehan Dubuque, Iowa	21½	23	44½

* Contract awarded.

1426 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 2, 1883.

MAJOR: I have the honor to present my annual report on improvement of Quincy Bay, Illinois, for the fiscal year ending June 30, 1883.

OPERATIONS IN 1882.

Under appropriation of \$15,000 made by act passed August 2, 1882, proposals were called for for continuing the work of dredging in the bay.

The contract was awarded September 26 to H. S. Brown, of Quincy, the lowest bidder, at a price of 20 cents per cubic yard for material deposited a distance of less than 1 mile, and 22 cents per yard for material deposited at a distance of more than 1 mile.

Work began October 7 on the bar near the Vandever Coru Planter Works, from which locality 7,038 cubic yards of material were removed.

It being found that the bar at the bay entrance was making fast and threatening to close it up, as well as blockade the city wharves, it was decided to dredge a deep cut across the bar to deep water in the main river, and accordingly the dredges were taken to that point and worked there from October 23 to November 24, when the cut was finished. From this cut 16,391 cubic yards of material were removed.

The effect of this cut was beneficial and the bar had nearly disappeared at the close of the season. On November 25 the dredge moved up to the bar at Wood's Slough and there operated until cold weather stopped the work; 586 cubic yards were removed from this bar.

OPERATIONS IN 1883.

Dredging was resumed March 27 and continued until April 4, when the dredges were taken to Hannibal, Mo. Returning from Hannibal April 24, they operated on the bars above the railroad bridge until June 15, when the contract was completed.

The work of 1883 resulted in the removal from the bar opposite Cedar Creek of 13,098 cubic yards, from the middle ground bar above the bridge 22,902 cubic yards, and from the bar on the main shore just above the bridge 3,659 cubic yards.

As the water was sufficiently high for the purpose, nearly all of the above amounts of material was deposited in sloughs and on low grounds at a distance of less than 1 mile from the place of removal.

The grade sought under this contract, as well as in previous years, was 4½ feet below low water of 1864.

Mr. W. A. Thompson, the inspector in charge of dredging, was very zealous and efficient.

SUMMARY OF WORK FOR FISCAL YEAR ENDING JUNE 30, 1883.

54,434 cubic yards material dredged, at 20 cents	\$10,886 92
9,242 cubic yards material dredged, at 22 cents	2,033 31
12½ hours' hire of dredge removing wreck, at \$12	150 00
Engineering and contingencies	1,727 66
Total	14,797 89

Summary of work to date.

Working season.	Names of contractors.	Excavation.
		<i>Cubic yards.</i>
October 18, 1879, to February 17, 1880	Whitney & Son	18,850.00
February 20, 1880, to May 22, 1880	do	80,551.10
August 31, 1880, to July 14, 1881	H. S. Brown	44,184.00
July 14, 1881, to April 29, 1882	do	45,408.29
October 7, 1882, to June 16, 1883	do	63,478.91
Total .....	.....	206,412.30

The amount of money expended to date for dredging in the bay is \$45,000, of which amount \$25,000 was appropriated for "Improving Quincy Bay," and \$20,000 allotted from appropriations of 1880 and 1881 for "Improving Navigation of Mississippi River at Quincy, Ill."

Average cost of dredging, 21½ cents per yard. The area dredged over covers about fifty-four acres, which, with the deep-water areas, makes about eighty-two acres of available harbor. The grade sought, however, was but 4½ feet below low water, while that of the original project and estimate called for 6 feet below low water over an area, including the deep-water sections, of about ninety acres, the amount of dredging proposed being about 680,000 cubic yards.

The principal part of future work will therefore be to lower the present grade from 4½ to 6 feet below low water.

A sketch showing location of work since the commencement of operations accompanies this report.

COMMERCIAL STATISTICS FOR 1882.

GENERAL BUSINESS.

Business.	Capital invested.	Value of sales.
Agricultural warehouses	\$125,000	\$430,000
Books, &c.	100,000	225,000
Boots and shoes	250,000	1,100,000
Butter and eggs	125,000	450,000
Clothing	320,000	950,000
Coal dealers	100,000	200,000
Coal, oil, salt, &c.	75,000	300,000
Crockery, &c.	80,000	180,000
Drugs, paints, &c.	475,000	1,067,000
Dry goods	550,000	1,500,000
Groceries	885,000	2,932,000
Hardware, &c.	255,000	620,000
Hats and caps	105,000	350,000
Hides, furs, &c.	185,000	1,000,000
Jewelry	65,000	180,000
Liquors and wines	250,000	955,000
Merchant tailors	140,000	495,000
Millinery	75,000	235,000
Moldings	30,000	75,000
Total	4,120,000	13,244,000

MANUFACTURES.

Business.	Capital invested.	Value of products.
Agricultural implements, plows, &c.	\$350,000	\$700,000
Baking powder	18,000	45,000
Blank books, binding, &c.	20,000	80,000
Boiler works	20,000	50,000
Breweries	300,000	500,000
Brickyards	100,000	250,000
Builders and contractors	250,000	425,000
Carriage factories	325,000	500,000
Cigar manufactories	90,000	140,000
Confectionery, &c.	80,000	550,000
Cooperages	100,000	300,000
Corp. anters	200,000	300,000
Fertilizing and Rendering Company	25,000	15,000
File works	12,000	45,000
Flouring mills	600,000	750,000
Furniture factories	280,000	500,000
Gas works	300,000	140,000
Hay-press works	75,000	150,000
Heating furnaces	40,000	90,000
Ice packers and dealers	400,000	550,000
Lime and cement	175,000	350,000
Lumber, saw-mills, &c.	600,000	1,500,000
Marble works	14,000	40,000
Printing offices	200,000	220,000
Organ factories	65,000	200,000
Paper boxes	12,000	20,000
Paper mill	180,000	300,000
Planing mill	250,000	500,000
Pork packers	200,000	400,000
Road-cart manufactory	50,000	4,000
Saddlery, &c.	180,000	450,000
Shirt factories	15,000	30,000
Show cases	15,000	45,000
Stone saw-mill	35,000	50,000
Stove works, &c.	700,000	1,200,000
Steam-governor works	110,000	180,000
Soap, chandlers, &c.	25,000	175,000
Tobacco works	500,000	2,000,000
Trunk factories	20,000	50,000
Water works	250,000	100,000
Wooden-ware works	15,000	22,000
Wire-fence works	8,000	5,000
Wagon factories	200,000	825,000
Total	7,822,000	14,228,000

1428 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

There wintered in Quincy Bay, 1881-'82, the following fleet: Seven steamboats, one steam-launch, two pile-drivers, three dredges, five quarter-boats, seven boat-houses, four dump-scows, ten ice-barges, thirty-five barges, six-log rafts, five lumber-rafts.

There passed through Quincy Bridge in 1882, 2,067 steamboats, 654 barges, and 391 rafts of logs and lumber.

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

W 19.

IMPROVEMENT OF THE MISSISSIPPI RIVER AT HANNIBAL, MISSOURI

At the commencement of the fiscal year there were no funds available under above head for prosecuting work in vicinity of Hannibal, and nothing was granted by act passed August 2, 1882.

The necessity for construction of Dike No. 3, extending from Illinois shore above ferry landing, becoming apparent from a survey made early in the spring of 1883, an allotment from the general appropriation was asked for and granted.

Details of the work may be found in report of C. W. Durham, assistant engineer, under head of "Improving Mississippi River from Illinois River to Des Moines Rapids."

There passed Hannibal Bridge in 1882, 3,031 steamboats, 578 barges, 2,278 strings of lumber, and 626 strings of logs.

ABSTRACT OF APPROPRIATIONS.

By act approved June 14, 1880	\$25,000
By act approved March 3, 1881	20,000
Total	45,000

Money statement.

Amount (estimated) required for completion of existing project	\$15,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	15,000 00

W 20.

IMPROVEMENT OF THE MISSISSIPPI RIVER AT LOUISIANA, MISSOURI.

No funds were granted by the act passed August 2, 1882, under this special head of appropriation, but the importance of improvement of the river in this vicinity being very great, an allotment of \$50,000 was made from the general appropriation for improving the Mississippi River.

Details of the work may be found in report of Assistant Engineer C. W. Durham, under above head.

There passed Louisiana Bridge in 1882, 1,249 steamboats, 472 barges, and 111 rafts of logs and lumber.

ABSTRACT OF APPROPRIATIONS.

By act approved March 3, 1881	\$10,000
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There was allotted to this work from the general appropriation, Mississippi River, Illinois River to Des Moines Rapids, the sum of \$50,000. Nothing is therefore asked for to complete existing project.

W 21.

IMPROVEMENT OF CUIVRE RIVER.

Under appropriation of \$5,000, made by act passed August 2, 1882, an agreement was made with H. S. Brown & Co. for dredging, at 22½ cents per cubic yard. Work was begun September 4 and completed September 29, 1882.

Twenty thousand cubic yards of material were dredged and removed. The work accomplished consisted in completing an 80-foot cut through Seed Tick Island Bar, and in making a cut of the same width through Flood's Bar and Monroe Bar, all being to a depth of 2 feet at extreme low water.

ABSTRACT OF APPROPRIATIONS.

By act approved June 14, 1880.....	\$2,000
By act approved March 3, 1881.....	5,000
By act passed August 2, 1882.....	5,000
Total	12,000

During the season of 1881 the snag-boat General Barnard worked in Cuivre River over two weeks, removing snags and cutting overhanging trees. When the dredges were sent in to work in September, 1882, the river was found in very bad condition; the banks had slid into the river, carrying with them a great number of snags and large trees. As the protection of the bank would entail an expense not at present justifiable, it would not seem practicable to keep the river clear of snags or other obstructions excepting by the yearly work of a snag-boat.

It is not practicable to present such statistics as would show the relation which the cost of such work would bear to the resulting benefits to navigation.

The work of original project, which yet remains undone, was intended to benefit navigation of the Mississippi River as well as improve the entrance to Cuivre River.

This work is therefore considered of sufficient importance to cause its retention in the estimates.

Money statement.

Amount appropriated by act passed August 2, 1882.....	\$5,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	5,000 00
Amount (estimated) required for completion of existing project.....	18,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	18,000 00

APPENDIX X.

PRESERVATION OF THE FALLS OF SAINT ANTHONY AND IMPROVEMENT OF THE MISSISSIPPI ABOVE THE FALLS—IMPROVEMENT OF CHIPPEWA AND SAINT CROIX RIVERS, WISCONSIN, AND OF MINNESOTA RIVER AND RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA—RESERVOIRS AT THE SOURCES OF THE MISSISSIPPI.

REPORT OF MAJOR CHARLES J. ALLEN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|---|---|
| 1. Preservation of Falls of Saint Anthony, Minnesota. | 7. Minnesota River, Minnesota. |
| 2. Mississippi River above the Falls of Saint Anthony, Minnesota. | 8. Red River of the North, Minnesota and Dakota. |
| 3. Construction of lock and dam on Mississippi River at Meeker's Island, Minnesota. | 9. Lock and dam at Goose Rapids on Red River of the North. |
| 4. Chippewa River, Wisconsin. | 10. Reservoirs upon the headwaters of the Mississippi River and its tributaries. |
| 5. Chippewa River at Yellow Banks, Wisconsin. | 11. Surveys for reservoirs at the sources of the Mississippi and its tributaries. |
| 6. Saint Croix River, Minnesota and Wisconsin. | |
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ENGINEER OFFICE, U. S. ARMY,
Saint Paul, Minn., July 25, 1883.

GENERAL: I have the honor to submit herewith the annual reports for the works in my charge for the fiscal year ending June 30, 1883.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

X 1.

PRESERVATION OF THE FALLS OF SAINT ANTHONY, MINNESOTA.

Work consisted in repairs to and preservation of the apron and crib-work, which in turn secure the safety of the concrete dike completed in 1876.

In consequence of high water, the work of repairing the apron below the lower rolling dam was not begun until the latter part of September. By means of flush boards erected on the crest of the rolling dam the water was turned off from the apron adjacent to the angle. Examinations of the river bed at the angle showed that an area of 100 feet by 80 feet had been scoured to an average depth of 8 feet since the examination made in August, 1881. This scour was partly due to the prolonged high water, but mainly to the effects of the spoil banks deposited

in 1881 and 1882 in the channel of the river above the crest of the falls, by J. B. Bassett and others. This scour caused the destruction of the crib-work under the toe of the apron at the angle, and much of the 4-inch plank decking was also destroyed by the giving way of the crib-work and by the action of logs running over the dam.

Much damage was also done to the extreme east end of the apron by the scour produced by tunneling under the east bank, which caused a crib to be carried out. This tunneling was done by owners of water-power on that side in the latter part of 1881.

The work of repair in the angle consisted in tearing away the damaged and displaced timber of the crib-work, and replacing it with two new cribs, one 67 feet long by 26 feet wide and 28 to 33 feet high, the other 8 feet long by 20 feet wide and 26 feet high, both cribs being sunk under the toe of the apron, and in renewal of the superstructure and decking.

Various smaller repairs were also made, and the crib bordering the approach to the log sluice was raised 5 feet in order to prevent logs from the Minneapolis mill-pond from passing, at high water, over to the angle.

In this general work of repair 265,032 feet, board measure, of timber, 11,798 pounds of iron, and 1,534 cubic yards of stone were used, and there were expended upon it the balance of old appropriations and part of appropriation made by act passed August 2, 1882.

In January, 1883, the construction of the crib as provided for in project submitted October 4, 1882, and approved, was begun. It was completed in March, and sunk March 6.

The object of this crib is to prevent any further scour of the bed of the river in the angle, and also to act as a buttress to strengthen the crib-work under the toe of the apron. It is 80 feet square and 6 feet high; constructed of 12-inch square pine timbers, solid side walls, and eight open interior cross-walls, filled compactly with stone and grouted. It is decked with 12-inch square timbers, drift-bolted to each other, and the bottom and deck of the crib are tied together by vertical iron rods.

One hundred and ninety-four thousand nine hundred and seventy-two feet, board measure, of pine timber, 43,869 pounds of iron, 827 cubic yards of stone, and 353 barrels of cement were used in the construction of this crib. In building it the first three courses and floor were put together on the ice; it was then slid into the water and the construction continued.

A temporary curbing of 2-inch plank, 16 feet high above the deck, was built around the sides of the crib and was furnished with the necessary valve gates. When the crib was ready for sinking, water was admitted through the gates, the crib settled into its position, and the curb disengaged from the crib.

Details of its construction are shown in accompanying drawings.

Previous to the sinking of the crib, the bed of the river had been leveled up with stone; and after it was sunk it was riprapped with stone.

In foundation and riprap, 3,023 cubic yards of stone were used. Mr. Archibald Johnson, assistant engineer, had local charge of this work, and to his skillful management is mainly due its success.

An examination made in April, one month after the crib was sunk, proved it to be in a satisfactory condition. The concrete dike is, so far as ascertained, in good condition.

Early in the spring of 1883, the Minneapolis Mill Company made connection between their mill-pond and the log-sluice, to facilitate the running of saw-logs over the falls.

The suit of the United States *vs.* J. B. Bassett, to force the latter to

remove the remains of the spoil bank deposited by him in 1881 and 1882 in the channel of the river above the falls, has progressed slowly in the United States district court of Saint Paul, and no decision has yet been reached.

As stated in the last annual report, the deposits of spoil, by contracting the area of discharge of the river, resulted in great damage to the United States works in the angle of the apron.

For the preservation of the falls it will be necessary, at no distant day, to extend the plan which was begun during the past fiscal year, until the crib-work at the toe of the apron is in great part, if not entirely, renewed; to extend the crib protection of the bed entirely across the river, and to secure the protection of the ledge at the east end of the apron.

It has been shown in preceding reports that the encroachments of the mill and water power companies upon the bed of the river had—before any work for the preservation of the falls was undertaken by the United States—reduced the width of discharge of the stream from about 1,400 feet to about 450 feet, through which narrow space the greater part of the flood waters from a drainage area of about 20,000 square miles plunge through a fall of 42 to 45 feet, carrying with them in the early spring more or less of ice, logs, &c.

The soft sand-rock forming the bed of the stream, just below the falls, is not of itself able to withstand the abrasion to which it is subjected.

As each year brings greater development of the water-power of the falls, the private works contracting the width of discharge become more permanent, and the difficulty of preserving the United States works of protection correspondingly increases. Added to this is the apparent disregard of the care of the Government in preserving the falls, as evidenced by the deposits in the channel and by the attempt at tunneling near the easterly end of the apron.

If the United States Government is to be further charged with the preservation of the falls, the sum of \$50,000 will be needed for the fiscal year ending June 30, 1885.

Original estimate for the present project	\$529,726 31
Remaining to be appropriated	134,726 31
Total amount expended to June 30, 1883, which includes amounts expended under original and present project, &c. (including outstanding liabilities)	603,538 78

This work is in the collection district of Minnesota. The nearest port of entry is Duluth, Minn., at which place the revenue collected during the fiscal year ending June 30, 1883, amounted to \$14,184.03.

ABSTRACT OF APPROPRIATIONS MADE FOR SAINT ANTHONY FALLS.

By act approved July 11, 1870 *	\$50,000
By act approved March 3, 1871 *	50,000
By act approved June 10, 1872 *	50,000
By act approved March 3, 1873 *	50,000
By act approved June 23, 1874	125,000
By act approved March 3, 1875	100,000
By act approved August 14, 1876	120,000
By act approved March 3, 1879 †	10,000
By act approved June 14, 1880 †	10,000
By act approved March 3, 1881 ‡	15,000
By act passed August 2, 1882 ‡	25,000
Total	605,000

* These sums were used before the adoption of the present plan.

† For sluice-way through public works, &c.

‡ For repairs and contingencies, &c.

1434 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Money statement.

July 1, 1882, amount available.....	\$11,428 15
Amount appropriated by act passed August 2, 1882	25,000 00
	36,428 15
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$34,653 57
July 1, 1883, outstanding liabilities.....	313 36
	34,966 93
July 1, 1883, amount available.....	1,461 22
Amount (estimated) required for completion of existing project.....	134,726 31
Amount that can be profitably expended in fiscal year ending June 30, 1885.	50,000 00

COMMERCIAL STATISTICS, 1882.

There are no steamboat navigation statistics to report, there being no steamers that ascend the Mississippi River to the Falls of Saint Anthony. There is, however, a small passenger steamer that makes daily trips between Saint Paul and Fort Snelling. Minneapolis (Falls of Saint Anthony) is a great manufacturing center, and its water-power is acknowledged to be the greatest in the world which has been put to practical use. Among its many industries the manufacture of flour stands at the head.

The following table gives the product and export of the Minneapolis mills for the years named:

Year.	Product.	Export.	Year.	Product.	Export.
	<i>Barrels.</i>	<i>Barrels.</i>		<i>Barrels.</i>	<i>Barrels.</i>
1860.....	30,000		1877.....	935,544	
1865.....	98,000		1878.....	940,786	109,188
1870.....	193,000		1879.....	1,551,789	442,596
1873.....	585,000		1880.....	2,051,840	769,442
1874.....	727,000		1881.....	3,142,974	1,181,322
1875.....	843,000		1882.....	3,124,919	
1876.....	1,000,675				

The above account of export represents only that which is shipped to foreign countries from the mills on through export bills of lading, and has no reference to sales made to eastern parties, and sent to seaboard points for export.

The maximum daily capacity of the flour mills is 25,650 barrels.

LUMBER PRODUCTION.

The following is a statement of the lumber production of the Minneapolis mills during the past thirteen years:

	Feet.
1870.....	118,233,100
1871.....	117,157,000
1872.....	167,918,820
1873.....	189,910,000
1874.....	191,305,680
1875.....	156,655,000
1876.....	200,371,250
1877.....	129,676,000
1878.....	130,274,100
1879.....	149,154,500
1880.....	195,452,200
1881.....	230,403,000
1882.....	312,239,000

LOGS.

From information received at the office of the Mississippi and Rum River Boom Company at Minneapolis, it appears that during the year 1882 6,281,000 feet of logs broke away from the booms of the company and passed over the apron of the falls before any boom was hung to guide them into the Government log-sluice. These logs were valued at \$50,248. They claim that 575,000 feet B. M. of logs were run through the Government log-sluice and valued at \$5,750. This last item of 575,000 feet B. M. is very much too large, as the boom which was intended to guide the logs into the log-sluice was part of the time broken, and when it was not broken its position was necessarily such in the river that not more than 5 per cent. of the logs sluiced into the river above the apron could be guided into the log-sluice. The probable quantity of logs, therefore, which passed through the log-sluice is 28,750 feet B. M., worth \$230. The quantity which passed over the apron would be 6,827,250 feet B. M., worth \$55,768.

X 2.

IMPROVEMENT OF THE MISSISSIPPI RIVER ABOVE THE FALLS OF SAINT ANTHONY, MINNESOTA.

The plan under which this work is carried on is based upon the project for the improvement of the stretch of river from Conrad's Shoals (35 miles below Brainerd) to Grand Rapids, the estimate being \$54,127.50, as given in the report of February 8, 1875, upon part of the third subdivision, Mississippi Transportation Route to the Seaboard, and was authorized in 1880, following the appropriation of \$15,000 made by act of Congress approved June 14, 1880.

The amount expended under this plan to June 30, 1883, is \$28,968.20, the work having been mainly confined to the river between Aitken, on the Northern Pacific Railroad, and Grand Rapids. Some bowlders were removed from the channel of the river at the Little Winnibigoshish Rapids, under authority from the Department, to facilitate the running of the United States steamboat, barges, and flats used upon the reservoir work.

The work during the fiscal year consisted in the removal of bowlders, snags, and leaning trees, as follows:

170 cubic yards of bowlders removed.

1,970 snags removed.

13,398 leaning trees and sweepers removed.

The work was done by day labor and purchase of materials. As a result of the work done to date all the rapids have been cleared of the worst bowlders, and about two thirds of the river from Grand Rapids to Aitken cleared of overhanging trees and snags.

At mean low water boats drawing 3 feet can run from Aitken to Grand Rapids. On the rapids the bowlders were removed so as to give a channel at least 60 feet wide.

As in the case of all streams where leaning trees and snags are the principal obstacles, more or less of snagging and clearing of trees will be necessary from time to time. Upon the completion of the reservoirs now under way above Grand Rapids, nothing will be needed for the maintenance of the improvement but snagging and clearing of trees, unless some of the banks should require revetment—a matter that will be reported upon as occasion may demand.

The sum of \$10,000 can be profitably expended during the fiscal year ending June 30, 1885, in removal of obstructions.

Aitken serves as a base of supplies for extensive lumber camps in Northern Minnesota.

1436 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Mr. Frederick Terry, in local charge of the work during the season of 1882, performed his duties well and faithfully. His report of last season's operations is herewith. Mr. W. S. Batson was assigned to the local charge of the work in June, 1883, and the work was resumed during that month, to be continued during the season as far the balance of the funds would admit of.

This work is in the collection district of Minnesota. The nearest port of entry is Duluth, Minn., at which place the revenue collected for the fiscal year ending June 30, 1883, amounted \$14,184.03.

ABSTRACT OF APPROPRIATIONS MADE FOR IMPROVING MISSISSIPPI RIVER, ABOVE FALLS OF SAINT ANTHONY, MINNESOTA.

By act approved June 23, 1874*	\$25,000
By act approved August 14, 1876*	20,000
By act approved June 14, 1880	15,000
By act approved March 3, 1881	10,000
By act passed August 2, 1882	10,000
Total	80,000

Original estimate for the work between the Falls of Saint Anthony and Saint Cloud, Minn. \$144,667 50

Remaining to be appropriated. 124,667 50

Original estimate for the work between Grand Rapids and Conrads Shoals 54,127 50

Appropriations by acts—

June 14, 1880	\$15,000
March 3, 1881	10,000
August 2, 1882	10,000
	35,000 00

Remaining to be appropriated. 19,127 50

Money statement.

July 1, 1882, amount available	\$3,359 27
Amount appropriated by act passed August 2, 1882	10,000 00
	13,359 27

July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$6,613 15
July 1, 1883, outstanding liabilities	714 32
	7,327 47

July 1, 1883, amount available 6,031 80

Amount (estimated) required for completion of existing project	19,127 50
Amount that can be profitably expended in fiscal year ending June 30, 1885	10,000 00

REPORT OF MR. FREDERICK TERRY, OVERSEER.

ENGINEER OFFICE, U. S. ARMY,
Saint Paul, Minn., November 28, 1882.

SIR: I respectfully submit the following report of the work done under my charge on the Mississippi River above Aitken, Minn., during the past season:

In obedience to your instructions, I proceeded to Aitken on May 1, and commenced fitting out the derrick-boats for the season's work. The boats having been fitted out and the crews hired, I was towed up the river with fleet No. 1 to 4 miles above Sandy Lake, the point at which work was discontinued in 1881, and on May 11, I commenced the cutting of leaning trees and removal of snags.

Fleet No. 2 was brought up and put to work on May 18. I worked the two derrick-boats, one on each side of the river, and, as each side presented about the same amount of work, they were never far apart; therefore I was able to keep them under my im-

* Made and expended before the adoption of the present project.

mediate supervision. I continued working the boats in this manner until August 5, when fleet No. 1 was laid up at a point about 4 miles above Pine Portage, and work was continued during the remainder of the season with only one derrick-boat. The distance of river cleared of leaning trees and snags previous to laying up fleet No. 1 was about 20 miles by water from the place of beginning. I continued work on the right bank of the river to Pine Portage with fleet No. 2 until August 18, when I had the fleet towed up to 8 miles above the mouth of Split-Hand River, the point at which work was discontinued in 1881, where I cleared the right bank of the river of obstructions down to the mouth of that river.

On September 2, the water having become so low that the steamboats were having trouble in getting over the different rapids, I dropped down to Crooked Rapids, and took out 60 cubic yards of rock, giving a good channel over that place.

This work was completed on September 13. I then moved down-stream to the rapids one-half mile above Ox-Bow Rapids, where I removed 10 cubic yards of rock. I then dropped down-stream to Ox-Bow Rapids, where I took out 16 cubic yards of rock. I then continued the plan of dropping down-stream, working on the different rapids as I reached them, and removing snags wherever they interfered with navigation. I reached Noyes' Rapids on September 20, and removed 15 cubic yards of rock. On September 22 I removed 6 cubic yards of rock from the rapids 5 miles above Sandy Lake. I commenced work on Moose Rapids on September 30, and in two days removed 10 cubic yards of rock. Island Rapids were reached on October 5, and the gravel bar which had formed across the head of these rapids was removed by raking the gravel into piles and then removing these piles with stone grabs. After the completion of the work I floated down stream, snagging as I went, to Aitken, which place was reached on October 31. On November 1 the boats were dismantled and the men discharged.

WORK ON LITTLE WINNIBIGOSHISH RAPIDS.

A small party, with a derrick-boat furnished by the force at Lake Winnibigoshish Dam, was put to work on Little Winnibigoshish Rapids on August 11, and completed their work on September 20; 93 cubic yards of rock were removed and a good channel secured except at a very low stage of water.

DETAILS OF WORK DONE.

Rock removed from—	Cubic yards.
Crooked Rapids.....	60
Rapids half mile above Ox-Bow Rapids.....	10
Ox-Bow Rapids.....	16
Noyes Rapids.....	15
Rapids 5 miles above Sandy Lake.....	6
Moose Rapids.....	10
Island Rapids.....	4
Little Winnibigoshish Rapids.....	93
Other points.....	10
Total amount of rock removed.....	224

Trees cut.

Month.	Diameter in inches.														Total.
	4 to 6	6 to 8	8 to 10	10 to 12	12 to 14	14 to 16	16 to 18	18 to 20	20 to 22	22 to 24	24 to 26	26 to 28	28 to 30	30 to 32	
May.....	1 637	963	720	588	452	278	206	124	102	72	50	38	30	29	5,279
June.....	3,707	1,723	1,123	903	773	458	321	160	140	50	78	1	2	51	9,490
July.....	1,888	1,186	842	702	549	293	193	121	107	59	97	2	4	5	5,998
August.....	1,490	1,157	816	697	531	350	246	170	141	96	69	23	0	44	5,830
September.....	35	30	20	18	15	10	8	9	1	3	1	0	0	0	150
October.....	0	0	0	5	9	0	0	5	0	0	0	0	0	0	19
Totals.....	8,697	5,059	3,521	2,913	2,329	1,389	974	589	491	280	295	64	36	129	26,766

Total number of snags removed..... 2,665

Very respectfully, your obedient servant,

FREDERICK TERRY,
Overseer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

1438 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

COMMERCIAL STATISTICS, 1882.

Lumber, lath, and shingles manufactured on the Mississippi River above the Falls of Saint Anthony.

Description.	1880.	1881.	1882.
Lumber.....feet B. M.	241, 157, 989	339, 162, 197	423, 009, 250
Shingles.....number.	88, 446, 125	128, 532, 050	168, 844, 000
Lath.....do.	49, 423, 100	70, 380, 750	77, 898, 000

LOGS.

The logs run during 1882 between Minneapolis and Saint Cloud amounted to 60,000,000 feet, valued at \$510,000, and on the river above Saint Cloud they amounted to 265,000,000 feet, valued at \$2,252,500; 135,000,000 feet passed Aitken.

Since 1878 there has been no use made of the river between Minneapolis and Saint Cloud for any purposes of commerce except the running of logs.

There were two steamboats and four barges engaged in the carrying trade between Aitken and Grand Rapids during 1882. The larger of the steamboats is 130 feet long and 22 feet beam, including guards 30 feet; she has a capacity for carrying about 70 tons. The smaller steamboat is 84 feet long and 14 feet beam, and carries about 25 tons. The barges have a capacity of about 127 tons; total capacity of steamboats and barges about 222 tons. The larger boat made twenty round trips and the smaller one seven round trips. They commenced running April 28, and ceased running November 8. The number of miles traveled was 9,180; the freight carried up and down stream amounted to 3,026,000 pounds; character of freight, was groceries, feed, and supplies of all kinds. The number of passengers carried was 1,764.

X 3.

CONSTRUCTION OF LOCK AND DAM ON MISSISSIPPI RIVER AT MEEKER'S ISLAND, MINNESOTA.

The project for this work is given in the Report of the Chief of Engineers for the fiscal year ending June 30, 1874, and the cost estimated at \$922,121.46, the object being to connect with the improvement of the Mississippi River below Saint Paul, so as to secure steamboat navigation up to the Falls of Saint Anthony.

No improvement of the river between Saint Paul and site of the proposed lock and dam has been authorized by Congress.

Congress, by act approved July 23, 1868, made a grant of 200,000 acres of public lands to the State of Minnesota to aid in constructing a lock and dam at this point in accordance with plan and estimate previously submitted.

By act approved March 3, 1873, Congress appropriated—

For construction of the lock and dam on the Mississippi River at Meeker's Island, Minnesota, according to the surveys and plans of the War Department, twenty-five thousand dollars: *Provided*, That all rights and claims in and to the land grant made to the State of Minnesota for the above work by act approved July twenty-third, eighteen hundred and sixty-eight, shall be fully relinquished to the United States before any of this appropriation is expended.

None of this appropriation has been used, the required relinquishment not having been made. This appropriation is but little more than 2½ per cent. of the estimate, and has been lying unused for ten years.

No appropriation is recommended for the fiscal year ending June 30, 1885.

This proposed work is in the collection district of Minnesota. The nearest port of entry is Duluth, Minn., at which place the revenues collected for the fiscal year ending June 30, 1883, amounted to \$14,184.03.

Beyond the running of loose saw-logs there are no commercial statistics to report.

Money statement.

July 1, 1882, amount available.....	\$35,000 00
July 1, 1883, amount available.....	25,000 00
Amount (estimated) required for completion of existing project.....	922,121 46

X 4.

IMPROVEMENT OF CHIPPEWA RIVER, WISCONSIN.

This work consists in the construction of dams and jetties to narrow the water-way, and revetment of banks with brush and stone, in accordance with the original plan of improvement.

Congress, by act passed August 2, 1882, appropriated the sum of \$35,000, for continuing the improvement. As soon as possible thereafter work by hired labor was begun on repairs to the jetties at the mouth of the river and in closing up the Dead Lake Cut-off—a dangerous division of the river into Dead Lake, in the vicinity of the entrance to Beef Slough.

Operations were continued, with some interruption, through the winter, teams and parties working on the ice.

During the fiscal year the following quantities of work were done :

Brush cut and put into the work.....	cords..	2,329
Stone quarried and put into the work.....	cubic yards..	6,981
Dams built.....	linear feet..	650
Dams repaired.....	do.....	2,310
Shore protected.....	do.....	1,839
Total quantity of stone used.....	cubic yards..	7,763
Total quantity of brush used.....	cords..	2,746

The points worked upon during the year were :

Jetties at the mouth.
 Bank near west jetty.
 Flower Pot Dam.
 Three-Mile Prairie.
 Little Missouri Dam.
 Waconia Island Dam.
 Twin Island Dam.
 Dead Lake Cut-off Dam.

All the work heretofore done is in good condition with one or two exceptions, and the low-water channel has been much benefited thereby, the increase in depth being from 16 to 18 inches to 3 feet, wherever works of improvement have been constructed and maintained.

Until, however, the large volume of sand which is annually discharged by the Chippewa can be sufficiently reduced by the protection of its banks generally, and especially of the Yellow Banks, more or less difficulty will be experienced at the mouth at a certain period of the year, usually in September.

Of the amount appropriated by act passed August 2, 1882, only a small part remains unexpended. This has been held back in order to make some repairs on the jetties, and some other work which can be done to advantage late in the fall.

The original estimate for the improvement of Chippewa River, d January 30, 1875, contemplated the removal of obstructions bet Eau Claire and its mouth at a cost of \$139,892.50, of which am \$64,102.50 was estimated as the cost of protecting the five high a banks, known generally as the Yellow Banks, below Eau Claire.

As the Yellow Banks have been made a separate item of approp tion in the river and harbor act, the deduction of that item leave the original estimate for the improvement of the Chippewa River p \$75,790. There has already been appropriated, however, for this \$83,000, and the present project is not yet completed.

The reason for the excess is that it became necessary to do a great of work that could not have been provided for in the estimate of 1 The jetties at the mouth have required more or less attention every on account of the treacherous nature of the bed upon which they built. Dead Lake Cut-off suddenly developed into a very danger change of the river's course, which, if it had not been arrested, might h cut off all navigation above it at low water. Wages, too, have proba been higher, owing to the general activity in the construction of public works.

As to future improvements on the Chippewa River, it is recommen that works of improvement be confined principally to that part of river lying between Waubeek Bank and the mouth.

It is only on this section of the river that a steamer now runs, nine-tenths of the difficulties to navigation may be said to occur u it. Above Waubeek Bank, or, more correctly, above Dunnville, ab 2 miles above the bank, there is only raft navigation at present, but is a business of great magnitude and value, requiring improved unobstructed channels.

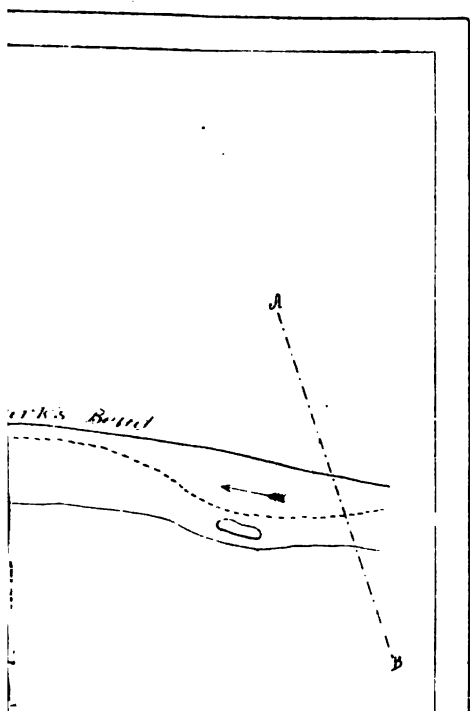
In accordance with this recommendation the shoals needing impre ment are:

	Cords brush.	Cubic of stone
Bear Creek Flats, two dams	1, 160	1
Durand Bar, one dam	960	1
Eau Galle Bar, one dam	636	1
Five-mile Bluff Bar, one dam	970	1
Shore protection above jetties	469	1
Maintenance of other work	500	
Repairs of jetties	1, 031	1
Total	5, 726	9
5, 726 cords of brush, at \$3.50		\$20, 041
9, 975 cubic yards stone, at \$2.50		24, 937
Total estimate		44, 978
Add for contingencies, 10 per cent		4, 497
		49, 476

The present low-water depth upon the first four named shoals is abo 18 inches.

The sum of \$35,000 can be profitably expended during the fiscal ye ending June 30, 1885, in furtherance of the present plan of improveme

The subject of bridging the Chippewa River has assumed consider ble importance during the past year. Three new bridges have be built at Eau Claire, and one is contemplated at Durand. There much need of legislative enactment of Congress fixing the requiremen for bridges spanning the Chippewa. Without such legislation it w



be difficult to prevent the navigation of the river from being impaired by bridges badly located and constructed.

The work during the past fiscal year has been in local charge of Mr. A. O. Powell, who has also, assisted later by Mr. F. D. Banning, had local charge of the protection of the Yellow Banks. These gentlemen are entitled to credit for faithful performance of duty. This appears a proper place in which to acknowledge the valuable services rendered upon these and other works of improvement by Mr. F. T. Hampton, principal assistant engineer in this office.

There has never been a thorough, connected survey of this river from Eau Claire to the mouth. The need of such is seriously felt. The annual report, 1879, placed the cost of one at \$6,000.

This work is in the collection district of Milwaukee, Wis. Milwaukee is the nearest port of entry, at which place the revenues collected for the fiscal year ending June 3, 1883, were \$——.

ABSTRACT OF APPROPRIATIONS MADE FOR IMPROVING CHIPPEWA RIVER, WISCONSIN.

By act approved August 14, 1876	\$10,000
By act approved June 8, 1878	10,000
By act approved March 3, 1879	8,000
By act approved June 14, 1880	10,000
By act approved March 3, 1881	10,000
By act passed August 2, 1882	35,000
	<hr/> 83,000

Revised estimate for completion of improvement under existing plan, not including appropriations to date, \$49,476.35.

Total amount expended to June 30, 1883, including outstanding liabilities, \$76,476.87.

Money statement.

July 1, 1882, amount available	\$505 23
Amount appropriated by act passed August 2, 1882	35,000 00
	<hr/> 35,505 23
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$26,736 59
July 1, 1883, outstanding liabilities	2,245 51
	<hr/> 28,982 10
July 1, 1883, amount available	6,523 13
	<hr/> Amount (estimated) required for completion of improvement as per revised estimate
Amount that can be profitably expended in fiscal year ending June 30, 1885	49,476 35
	<hr/> 35,000 00

COMMERCIAL STATISTICS, CHIPPEWA RIVER, 1882.

375,000,000 feet lumber, at \$16 per M	\$6,000,000
150,000,000 shingles, at \$2 80 per M	420,000
68,000,000 lath, at \$2 per M	136,000
2,200,000 pickets, at \$16 per M	35,200
5,000 railroad ties at 40 cents each	2,000
350,000,000 feet logs, Beef Slough, at \$12 per M	4,200,000
Total	<hr/> 10,793,000

Two steamboats plied between Read's Landing and Eau Claire, and one between Read's Landing and Dunnville; they commenced running April 3, 1882; they ceased running between Read's Landing and Eau Claire July 16, 1882, and between Read's Landing and Dunnville November 23, 1882.

Number of tons of freight carried.....	1,320
Number of passengers and raftmen carried.....	10,490
Amount received for carrying freight and passengers.....	\$25,220

The building of the Chippewa Valley and Superior Railroad will have the effect of stopping the running of steamboats to Eau Claire or above the mouth of the Menomonee, but the Knapp, Stout & Co. company will continue to run their boat, the steamer Phil. Sheckel, between Read's Landing and Dunnville, to carry raftmen and such of their freight as may come by river to Read's Landing; but Durand and Eau Claire freight will, no doubt, go all rail.

X 5.

IMPROVEMENT OF CHIPPEWA RIVER AT YELLOW BANKS, WISCONSIN.

The object of this work is to prevent the wearing away of the high sand banks or bluffs on the Chippewa River below Eau Claire, and thereby relieve this river as well as the Mississippi below it from the incumbrance of the immense volumes of sand constantly sliding into the stream as the base of the slope is scoured by the action of the current. There are five of these banks below Eau Claire, as follows:

1. A bank about 1 mile below Eau Claire, about 2,000 feet in length and 20 feet in height.
2. A high bluff, known as twelve-mile Bank, 12 miles below Eau Claire, 6,300 feet in length and about 175 feet in height. The up-stream half of this bank is covered with vegetation; the remainder is a continuous slope of sand.
3. The Mary Dean Bank, 19 miles below Eau Claire, 6,900 feet long and 145 feet high, has a slope of loose, unprotected sand.
4. Rumsey's Yellow Bank, 22 miles below Eau Claire, 4,700 feet long and 140 feet high.
5. Waubeek Yellow Bank, 32 miles below Eau Claire, 3,800 feet long and 135 feet high.

The slope of these banks is about $1\frac{1}{2}$ on 2, and the length requiring protection 24,000 feet nearly.

The protection of these banks was considered in the report upon the improvement of the Chippewa River, January 30, 1875, and the estimated cost of their protection, \$64,102.50, included in the cost of improving the Chippewa River below Eau Claire. Congress, by act passed August 2, 1882, appropriated the sum of \$30,000 for the protection of these banks, making the work a distinct one.

The project for commencing the work was not authorized until February 7, 1883. Operations were begun on the Waubeek Bank early in May following. The work consists in building a revetment wall of piles and saw-mill edgings, about 10 feet high and 14 to 16 feet in width at the base of the slope; the edgings laid in courses slightly diagonal to the axis of the stream, one course pointing diagonally up-stream and the other diagonally down-stream; also in constructing three belts or terraces, each 10 feet in width, at equal distances apart on the faces of the slopes, and which are to be covered with indigenous growth. The wall or revetment is to prevent destruction of the base of the slope, and the terraces are to hasten the restoration of vegetation, which will, in turn, protect against drifting. Willow brush is also used in the lower courses of the revetment wall for the purpose of inducing a growth of willows at the foot of the slope.

At the close of the fiscal year, 1,135 piles had been driven at Wau-beek and Rumsey's banks, and 1,655 cords of edgings and brush had been put into the work at the Waubeek Bank, making 1,200 linear feet of finished revetment and 500 linear feet partly completed. With the balance of funds on hand the work will be pushed during the coming season, and it is expected that by the latter part of October from 7,000 to 8,000 linear feet of protection will have been completed, which will exhaust the appropriation.

The *exact* rate of cost of this work is not yet fully determined. The method is somewhat experimental so far as deciding whether it is the cheapest as well as the most effective.

It was first proposed to build the wall, at the base of the slope, entirely of mill edgings on account of their alleged cheapness, but the difficulty of getting this material to the work made it excessively high, and it has been temporarily abandoned and brush substituted.

Piles are used on the outside of the wall to protect it from abrasion by logs and rafts and to strengthen it, in the absence of stone, which it is quite impracticable to get. As the brush wall is carried up sand is thrown upon each course of fascines, to consolidate the wall. The weight secured by this filling, and by the superincumbent mass of sand and soil which will be above high water, will be sufficient to prevent the brush from being displaced by high water.

It is believed that when the present season's work is completed the cost of the protection will average about \$4 per linear foot (of wall and terrace), and upon this basis the cost of protecting 24,000 linear feet, the aggregate length of the five banks named above, will be about \$96,000. Improvements in the method of work, however, that may be discovered as it proceeds, may reduce the cost below this last figure, but the cost of each bank will vary, depending upon the facility with which material can be obtained. The original estimate was made eight years ago, and contemplated brush and stone revetment. But, leaving out the matter of change in prices of material and labor during the past eight years, there was, at the time the estimate was rendered, no actual experience in the cost of such revetment upon which to base one. The magnitude of the Yellow Banks calls, also, for a character of work different from ordinary shore protection.

The sum of \$30,000 can be profitably expended upon these banks during the fiscal year ending June 30, 1885.

Total amount expended to June 30, 1883, including outstanding liabilities, is \$13,120.70.

This work is in the collection district of Milwaukee, Wis. Milwaukee is the nearest port of entry, at which place the revenues collected for the fiscal year ending June 30, 1883, were \$—.

For commercial statistics, see Annual Report, improving Chippewa River, Wisconsin.

Money statement.

Amount appropriated by act passed August 2, 1882.....	\$30,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$4,054 64
July 1, 1883, outstanding liabilities.....	9,066 06
	<hr/> 13,120 70
July 1, 1883, amount available	<hr/> 16,879 30
Amount (estimated) required for completion of improvement as per revised estimate	66,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	30,000 00

X 6.

IMPROVEMENT OF SAINT CROIX RIVER BELOW TAYLOR'S FALLS, MINNESOTA AND WISCONSIN.

The original project for the improvement of this river was based upon the report of a survey made in 1874, and contemplated the removal of snags, bowlders, wrecks, leaning trees, and sand-bars between Taylor's Falls and Prescott, and the contraction of the low-water channel between Taylor's Falls and Stillwater into one of nearly uniform width by means of brush and stone jetties, and dams of same material to close island chutes and secondary channels.

The present project is based upon the same general method, but upon an estimated cost of \$60,250, based upon the results of a survey made in 1879, which estimate (see letter of February 25, 1882, page 1816 *et seq.*, Part II, Report of the Chief of Engineers 1882) was increased to \$83,450.

The estimate resulting from the survey made in 1874 was much too low, the river during the time of that survey having been at too high a stage to admit of all obstructions being seen or even appreciated.

The first appropriation for the improvement of the Saint Croix was \$10,000, by act of Congress approved June 18, 1878.

At that date the river bed was a mass of sunken cribs, old piles, snags, bowlders, and bars, and banks encumbered by leaning trees. The low-water channel had in many places but little more than two feet of water, and steamers and barges made their way as best they could amongst the obstructions.

Congress, by act passed August 2, 1882, appropriated \$30,000 for continuing the improvement. Operations for the past fiscal year under this appropriation were resumed with hired labor in August, and have progressed steadily since, with the exception of two and a half months of interruption during the closing and opening of navigation.

Above Stillwater the work consisted in the construction of dams and shore protection of brush and stone, and in the removal of obstructions from the channel, the following points having been worked upon: dams were built at Sweazie's Bar, Tipcon's Landing, Kelly's Slough, Conglomerate Rock Slough, and at Cedar Bend and Boom Island; and repairs were made on dams at Boom Island, Osceola Island, Mile Island, McLeod's Lake, Marine Bar, and Kelly's Slough.

Six thousand one hundred and seventy-five cubic yards of stone and 822 cords of brush were used in the work, 1,777 linear feet of dams and 1,379 linear feet of shore protection having been built. In addition there were removed—

Snags.....	87
Trees.....	55
Stumps.....	258
Cribs.....	6
Wreck from the channel.....	1

Below Stillwater but two points required immediate attention, viz, Hudson (or Willow River) Bar and Catfish Bar, the latter 7 miles below Hudson. At the first-named place a pile and sheet dam was commenced during the latter part of the season of 1882, its design being two-fold: to cut off at low water the useless small channels which detract from the main channel, and also to act as a training-dam, or sheer, to keep rafts off the bar. It will be 3,000 feet long, of piles driven 3 feet between centers, and sheeted on the inside or channel side; top of dam 3 feet above low water. This method of construction is used for economy's sake, as brush and stone are difficult to get.

Three hundred and fifty piles have been driven in this work.

At Catfish Bar the work so far has consisted in straightening the channel by cutting through a narrow spit of sand and gravel which projects from the left bank into the lake about 1,400 feet, or nearly three-fourths across its width. The channel is to be excavated to a width of 400 feet, the length of excavation from 125 to 150 feet; depth at low water to be 5 feet; deep water exists above and below the spit.

One thousand five hundred cubic yards of gravel were removed by scraping last fall.

As Saint Croix Lake is affected easily by the stages of the Mississippi River, the work below Stillwater has been subject to frequent interruption.

A scraper-boat was built last fall, but, owing to the lateness of the season, it was used only for a few weeks. It is expected to do good work during the coming low water.

During the past year the natural condition of the river has been most satisfactory for boat navigation; a general depth of 3 feet existing in the channel at low water from Taylor's Falls to Stillwater, and 4 feet from the latter place to Prescott, at the mouth of the river. No boat has been delayed by low water, but much interruption has been experienced from running of logs and operation of booms.

The work above Stillwater has been in local charge of Capt. O. F. Knapp, overseer, and that below Stillwater in local charge of Mr. Geo. H. Christian, jr., overseer, and Capt. S. M. Register. These gentlemen have all performed their duties well.

The conflict between logging and boating interests continues. It is the general impression on the river that the executive branch of the Government can regulate these troubles, but Congress alone has power in the matter, and to it the people interested must look for relief.

Balance on hand June 30, 1883, to be applied during the coming season in prosecuting the work already begun, \$12,674.67.

The sum of \$35,450 can be profitably expended during the fiscal year ending June 30, 1885, in completing the work according to the plan approved.

Estimated cost of improvement as amended	\$83,450 00
Amount expended before its adoption	18,000 00
Total amount expended to June 30, 1883 (including outstanding liabilities) ..	53,325 33

This work is in the collection district of Minnesota. The nearest port of entry is that of Duluth, Minn., at which place the revenue collected during the fiscal year ending June 30, 1883, amounted to \$14,184.03.

ABSTRACT OF APPROPRIATIONS MADE FOR IMPROVING SAINT CROIX RIVER BELOW TAYLOR'S FALLS, MINNESOTA AND WISCONSIN.

By act approved June 18, 1878*	\$10,000
By act approved March 3, 1879*	8,000
By act approved June 14, 1880†	10,000
By act approved March 3, 1881	8,000
By act passed August 2, 1882	30,000
Total	66,000

* Appropriated before adoption of original project, and the project based upon the report of the survey of 1879 (see report of Capt. Charles J. Allen, January 26, 1880, printed as House Ex. Doc. No. 40, Forty-sixth Congress, second session), and before the adoption of the existing project, cost \$83,450. Two thousand dollars of the appropriation of 1879 was used in making survey of the river from Taylor's Falls to Prescott during 1879.

† About \$300 of this amount was expended in the improvement of the slough on the east side of the river, known as the canal, between Four-mile Island and the foot of Saint Croix Boom.

1446 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Money statement.

July 1, 1882, amount available.....	\$23 57
Amount appropriated by act passed August 2, 1882.....	30,000 00
	<u>30,023 57</u>
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$16,150 80
July 1, 1883, outstanding liabilities.....	1,198 10
	<u>17,348 90</u>
July 1, 1883, amount available.....	12,674 67
	<u>35,450 00</u>
Amount (estimated) required for completion of existing project.....	35,450 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	35,450 00

COMMERCIAL STATISTICS.

FREIGHT AND PASSENGERS.

There were three steamboats and twenty-four barges engaged exclusively in the freight and passenger business during the season of 1882.

There were one hundred and eighty-five round trips made between Taylor's Falls and Stillwater and one hundred round trips between Marine and Franconia and Saint Paul. The steamboats are reported as having carried during the season 10,300 passengers, 9,275,000 pounds of miscellaneous freight, 7,800 cords wood, 518 head of cattle, 1,278 barrels of salt, 6,580 barrels of lime, 8,225,487 feet, B. M., lumber.

LUMBER, LOGS, RAFTING, AND TOWING, 1882.

There were nineteen regular steamboats engaged in the towing of logs and lumber, and a total of seventy-seven log and lumber towing steamboats engaged in the same business on the Saint Croix and Mississippi rivers together. Some of the Mississippi River steamboats made occasional trips into the Saint Croix and are not included in the above nineteen.

There were 130,000,000 feet of logs towed out of the Saint Croix River.

There passed through the Saint Croix Boom 276,575,640 feet of logs, which at \$11 per M feet would amount to \$3,042,552 04

Manufactured:

Lumber, 116,320,590 feet, B. M., at \$13 per M.....	1,512,167 67
Shingles, 62,408,750 pieces, at \$2 per M.....	124,817 50
Lath, 32,042,500 number, at \$1.50 per M.....	48,063 75
Pickets, 200,000 number, at \$12 per M.....	2,400 00

Total valuation..... 4,730,000 96

Opening and closing of navigation on the Saint Croix River.

Years.	Opened.	Closed.	Years.	Opened.	Closed.
1863.....	April 7	November 20	1878.....	April 5	November 25
1864.....	April 5	November 12	1874.....	April 15	November 15
1865.....	April 18	November 20	1875.....	April 12	November 15
1866.....	April 10	November 25	1876.....	April 18	November 25
1867.....	April 10	November 24	1877.....	April 8	December 31
1868.....	March 26	November 25	1878.....	April 2	November 29
1869.....	April 9	November 13	1879.....	April 4	November 17
1870.....	April 5	November 21	1880.....	April 1	November 12
1871.....	March 29	November 22	1881.....	April 12	November 14
1872.....	April 8	November 20	1882.....	April 3	November 28

X 7.

IMPROVEMENT OF MINNESOTA RIVER, MINNESOTA.

No work done during the fiscal year for want of funds.

The project for the improvement of the river from its mouth to South Bend (see page 364, Part I, Annual Report of the Chief of Engineers for 1875) contemplated the construction of five locks and dams, and removal of snags, &c., at an estimated cost of \$733,868.63. The last appropriation for this stream was made by river and harbor act approved June 18, 1878, and consisted of \$10,000.

There has been expended, since the commencement of work upon that stream, the sum of \$117,458.

The stream has no commerce worth reporting. No appropriation is asked for the fiscal year ending June 30, 1885.

This work is in the collection district of Minnesota. The nearest port of entry is Duluth, Minn., at which place the revenue collected during the fiscal year ending June 30, 1883, amounts to \$14,184.03.

The commerce of the river, even before the advent of the railroad through the Minnesota Valley, was not large in any one season, and since that time only an occasional small "wild" packet has ascended the river.

In May, 1876, two steamboats that went up the river during high water had to discharge their return freight at Mankato before they could return to the Mississippi River, owing to the great number of snags and other obstructions. With the appropriations by Congress August 14, 1876, and June 18, 1878, however, a large number of these obstructions were removed, though perhaps not in sufficient numbers to make the river an easy one to navigate during periods of low water.

ABSTRACT OF APPROPRIATIONS MADE FOR THE IMPROVEMENT OF THE MINNESOTA RIVER.

By act approved March 2, 1867	\$37,500
By act approved July 11, 1870	10,000
By act approved March 3, 1871	10,000
By act approved June 10, 1872	10,000
By act approved March 3, 1873	10,000
By act approved June 23, 1874 *	10,000
By act approved March 3, 1875	10,000
By act approved August 14, 1876	10,000
By act approved June 18, 1878	10,000
Total	117,500

Amount (estimated) required for completion of existing project (see page 364, Part I, Annual Report of Chief of Engineers for 1875), \$733,868.63.

Money statement.

July 1, 1882, amount available	\$33 00
July 1, 1883, amount available	33 00
Amount (estimated) required for completion of existing project	733,868 63

* Used in making survey of river.

X 8.

IMPROVEMENT OF RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA.

The original (which is, with slight modification, the existing) plan for the improvement of this river from Breckenridge to the boundary line between the United States and Manitoba, as given in the Annual Report for the fiscal year ending June 30, 1881, was estimated to cost \$145,310.18, the work to consist in dredging and removal of obstructions from the channel. Like many of the estimates of cost of work rendered six or eight years ago, this estimate has proven too low. In a report of December 8, 1877, the estimates, based upon the reports of 1874 and 1875, and information to date, contained the following-named items:

For improving the river from Breckenridge to Moorhead for raft and flat-boat navigation.....	\$22,663 98
For improving the river from Moorhead to the head of Goose Rapids.....	4,428 00
For improving the river from Goose Rapids to Frog Point.....	32,880 20
For improving the river from Frog Point to boundary line.....	85,338 00
Total.....	145,310 18

Further examination and experience gained since the work was commenced have shown that the quantity of excavation necessary to the improvement was underestimated in 1877, especially upon the important reaches of river between Moorhead and the head of the rapids, and between Frog Point and the boundary line.

Assistant Davenport, whose estimate is herewith, places the amount of dredging necessary to complete the improvement as follows:

	Cubic yards.
Breckenridge to Moorhead.....	40,000
Moorhead to Goose River at the head of the rapids.....	60,000
Goose River to Frog Point.....	53,887
Frog Point to the boundary line.....	200,000
Total.....	353,887

Which, at an estimated cost of 20 cents per cubic yard, amounts to \$70,777.40.

According to the estimate of 1877, the sum of \$32,310.18 would have been considered as the amount necessary to complete the improvement. Adding to this the funds available June 30, 1883, viz, \$4,504.02, we have \$36,814.20 to subtract from the above; or, in other words, we have to add in round numbers \$34,000 to the estimate of 1877, making it stand \$179,310.18, instead of \$145,310.18.

Congress, by act passed August 2, 1882, appropriated \$10,000 for continuing the improvement. With this appropriation and the balance of funds available from former appropriations, the work of dredging and removal of obstructions was continued during the season of 1882.

One dredge fleet operated between Moorhead and the head of Goose Rapids; another dredge fleet worked upon the Turtle River bars below Grand Forks, and the steam derrick and tenders removed a number of the worst boulders from Goose Rapids.

The first-named fleet worked over 17 miles of river, removing 65,197 cubic yards of material from the channel. The second-named fleet worked over 18 miles of river, removing 47,342 cubic yards from the channel.

The steam derrick worked over 40 miles of river, viz, from Moorhead to a point 16 miles below, and from Caledonia to Frog Point, includ-

ing Goose Rapids, removing one hundred and thirty-seven snags, one hundred and ninety-eight stumps, two hundred and eighty-nine overhanging trees, and 321 cubic yards of bowlders from the channel.

Total amount of material removed by the dredges since the commencement of operations in 1879, 261,738 cubic yards.

The work has been done by day labor. The material dredged, a tough, leathery clay, and not liable to wash, was deposited systematically in the bends at the points of dredging, for the purpose of serving as training-walls or dikes, and also to maintain, as far as possible, the area of discharge of the stream after dredging, the same as before dredging. Careful examinations since 1879 have shown that these walls or deposits of clay have not been affected to any appreciable extent by the heaviest floods.

From the commencement of the dredging in 1879, to date, the dredges have worked over 98 miles of river, affording for a distance of 80 miles below Moorhead (Fargo, Dak., opposite), and consequently above the rapids, an assured navigation with dredged channels not less than 60 to 80 feet in width, and depth of 3 feet at *lowest water*; and 18 miles of 4-foot channel below Grand Forks. Assistant Davenport, in local charge of the work, and whose complete and interesting report of season's operations 1882 is herewith, states:

The benefits of the dredged channel were never more apparent than during the latter part of the season of 1882. From the 15th of August until the close of navigation the discharge at Caledonia was reduced to about 1,500 cubic feet per second, and on the *undredged* portions of the river there was but 30 inches on the bars, or mud lamps, while in the dredged channels there was in no case less than 50 inches.

About 40,000 cubic yards of material in the channel just above Fargo should be removed. This item has assumed importance within the past two years; in fact, the improvement of the river from Fargo to Breckenridge is now of almost as much importance as is the improvement immediately below Moorhead.

No river and harbor act was passed by Congress last winter, the act passed August 2, 1882, being the last one.

There being, upon the opening of navigation in 1883, only a small balance of funds remaining, it was found necessary, after putting the floating property in repair, to harbor it, for the present, at Grand Forks.

The sum of \$30,000 can be profitably expended during the fiscal year ending June 30, 1885, in furtherance of the plan of improvement.

The total amount expended to June 30, 1883, including outstanding liabilities, is \$108,495.98.

The Red River of the North is in the collection district of Minnesota, with Saint Vincent, Minn., the port of entry. The amount of duties collected at Pembina, Dak., and Saint Vincent, Minn., during the fiscal year ending June 30, 1883, was \$28,993.99.

ABSTRACT OF APPROPRIATIONS MADE FOR IMPROVING RED RIVER OF THE NORTH,
MINNESOTA AND DAKOTA.

By act approved August 14, 1876.....	\$10,000
By act approved June 18, 1878.....	30,000
By act approved March 3, 1879.....	25,000
By act approved June 14, 1880.....	20,000
By act approved March 3, 1881.....	18,000
By act passed August 2, 1882.....	10,000
Total.....	113,000

Revised estimate of cost of improvement from Breckenridge to boundary line, not including lock and dam at Goose Rapids, \$179,310.18; remaining to be appropriated, \$66,310.18.

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Money statement.

July 1, 1882, amount available.....	\$12,137 56
Amount appropriated by act passed August 2, 1882.....	10,000 00
	<hr/> 22,137 56
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	17,633 53
July 1, 1883, amount available.....	<hr/> 4,504 02
Amount (estimated) required for completion of improvement, per revised estimate, not including lock and dam at Goose Rapids	66,310 18
Amount that can be profitably expended in fiscal year ending June 30, 1885.	30,000 00

REPORTS OF MR. R. DAVENPORT, ASSISTANT ENGINEER.

1.

ENGINEER OFFICE, UNITED STATES ARMY,
Saint Paul, Minn., January 1, 1883.

SIR: I have the honor to submit the following report of operations on the Red River of the North, and the cost of the work done in improving the same during the season of 1882:

DREDGE NUMBER 1.

Dredge No. 1 commenced work at Moorhead on May 1, and after working there for a week was moved down river to Cut No. 76, in section 2, township 144, range 49, where the work was discontinued last year. After arriving at that point the work progressed steadily until 21st of October, when the dredge was taken to Moorhead and dismantled for the winter.

During the season the dredge worked over 17 miles of river, removing 65,197 cubic yards of clay, opening a channel 80 feet wide and 3 feet deep at low water throughout that distance. The work ended with the completion of Cut No. 83, in section 13, township 145, range 49.

From May 1 until June 30 the scow derrick worked with the dredge rehandling the material dug from the channel. After June 30 the dredge worked alone, the material excavated being conveyed to the training-dams by a slide-scow, as in former years. The cost of the work, including everything chargeable to the dredge, pay-roll, subsistence, fuel, supplies, proportion of steamboat expenses, superintendence, &c., was 11.4 cents per cubic yard. Total number of days, 174; working days, 150; average digging, 434½ cubic yards per day.

The dredge worked remarkably well during the entire season; the stage of water, excepting a few days in May, was favorable, and there were no detentions from any cause.

COST OF OPERATING DREDGE NUMBER 1.

Pay-roll, average per day	\$20 29
Repairs, average per day	1 40
Supplies, average per day (oil, tallow, &c.)	1 41
Outfit, average per day (replacing tools, rope, &c.)	1 34
Fuel, average per day (\$3 per cord)	4 99
Steamboat expenses and superintendence	7 47
Subsistence per ration (average crew, ten men)	59

Average daily expenses, \$42.80; or \$7,447.20 for the season of one hundred and seventy-four days.

DREDGE NUMBER 2.

Dredge No. 2, on account of extreme high water, did not commence work at Grand Forks until June 12; but from that time until October 21, when the work was discontinued, excavated 47,342 cubic yards, opening a channel 80 feet wide and 4 feet deep at low water, through 18 miles of river.

The material excavated was conveyed to the training-dams by a slide-scow. In some localities the width of the river necessitated the rehauling of the clay, &c., with the dipper. Thirteen large snags were removed from the channel below Grand Forks.

The dredge worked satisfactorily during the entire season, though the high water that continued on the river below Grand Forks interfered with the work and materially reduced the average digging.

COST OF OPERATING DREDGE NUMBER 2.

Pay-roll, average per day.....	\$17 89
Repairs, average per day.....	1 30
Supplies, average per day (oil, tallow, &c.).....	1 86
Outfit, average per day (replacing rope, tools, &c.).....	30
Fuel, average per day (\$2.15 per cord).....	2 54
Steamboat expenses and superintendence.....	7 47
Subsistence, per ration, (average crew, ten men).....	63½

Average daily expense, \$37.51; or \$4,977.72 for the season of one hundred and thirty-two days.

Number of working days, 113; average digging, 419 cubic yards per day; cost per cubic yard, 10¼ cents.

SCOW DERRICK.

The scow derrick, new this season, worked with dredge No. 1 until June 30, and was found to be well adapted to the work for which it was intended, viz, conveying the material excavated by the dredge to the training-dams, where the river is too wide for the dredge and slide-scow. The dredge and derrick can carry the material 58 feet, and with the addition of a slide-scow 78 feet. The dredge and slide-scow have a reach of only 48 feet.

On the 1st of July the scow derrick was taken to Moorhead, and the machinery, &c., arranged for the removal of snags and bowlders. Work was resumed on July 12, and from that time until the 10th of October the boat worked over 40 miles of river, viz, from Moorhead to a point 16 miles below, removing one hundred and thirty-seven snags, one hundred and ninety-eight stumps, and two hundred and eighty-nine overhanging trees; and from Caledonia to Frog Point (Goose Rapids), 24 miles, removing 321 cubic yards of bowlders from the channel.

One hundred and fifty linear feet of wing-dam were built, with the bowlders removed. Cost of removal of snags, trees, and stumps, \$2.16 per snag, &c.; cost of removal of bowlders, \$4.79 per cubic yard.

COST OF OPERATING THE SCOW DERRICK.

Pay-roll, average per day.....	\$13 18
Repairs, average per day.....	39
Supplies, average per day (dynamite, oil, tallow, &c.).....	2 36
Outfit, average per day (replacing rope, tools, &c.).....	77
Fuel, average per day (per cord, \$3).....	1 59
Steamboat expenses and superintendence.....	7 47
Subsistence (per ration).....	62½

Average cost per day, \$32.01; average crew required, ten men (in the cost of the work as given above, dredging, the removal of snags, bowlders, &c., the cost of superintendence and maintaining the steamboat has been divided proportionally between the dredges and scow derrick). Working with a dredge, the scow derrick can be operated at the following cost:

Pay-roll, average per day.....	\$6 50
Fuel, average per day (\$3 per cord).....	4 50
Repairs, average per day.....	50
Machinery supplies, average per day (oil, tallow, &c.).....	1 00
Outfit, average per day (replacing tools, &c.).....	1 00
Steamboat and superintendence.....	7 47

Total..... 20 97

The new steamboat commenced operations on July 1, and worked satisfactorily during the rest of the season. The boat was of great benefit in facilitating the direction of the work, and saved both time and expense in towing the different fleets and wood barges, and in carrying supplies, &c. The number of miles run was 3,061, at an expense of 60 cents per mile, or an average cost of \$16.41 per day for the season of one hundred and thirteen days.

COST OF OPERATING THE STEAMBOAT.

Pay-roll, average per day.....	\$9 91
Machinery supplies, per mile run.....	01
Repairs, per mile run.....	01½
Fuel, per mile run.....	07½
Subsistence, per ration (average crew, five).....	64½

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Summary of work done in 1882.

Removed by—	Before June 30.	After June 30.	Length of river worked over.
	<i>Cubic yards.</i>	<i>Cubic yards.</i>	<i>Miles.</i>
Dredge No. 1.....	12, 895	52, 302	17
Dredge No. 2.....	3, 925	43, 417	18
Total.....	16, 820	95, 719	35

Total cubic yards removed, 112,539.

Removed by—	Snags.	Trees.	Stumps.	Boulders.	Length of river worked over.
				<i>Cubic yards.</i>	<i>Miles.</i>
Scow derrick.....	137	289	198	321	40
Dredge No. 2.....	13				
Total.....	150	289	198	321	40

From the commencement of the improvement in 1879 to the close of navigation in 1882 the dredges have worked over 98 miles of river, making 80 miles of 3-foot low-water channel above Goose Rapids, and 18 miles of 4-foot channel below Grand Forks.

The benefits of the dredged channel were never more apparent than during the latter part of the season of 1882. From the 15th of August until the close of navigation the discharge at Caledonia was reduced to about 1,500 cubic feet per second, and on the undredged portions of the river there was about 30 inches on the bars or mud lumps, while in the dredged channels there was in no case less than 50 inches.

Careful soundings taken during the extreme low water also showed that the dredged channels and training dams were unaffected, to any appreciable degree, even by the great floods of 1881-'82.

The removal of snags, trees, stumps, and boulders has also materially lessened the dangers of navigation on the portions of the river worked over, the removal of boulders from the channel on Goose Rapids being particularly helpful, not only in taking away dangerous obstructions, but also in making all the water on the rapids available.

Very respectfully, your obedient servant,

E. DAVENPORT,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

2.

SAINT PAUL, MINN., July 1, 1883.

SIR: The following is respectfully submitted in answer to your order directing me to prepare an estimate of the cost of completing the improvement of the Red River of the North, and your inquiry as to the reason why an increase in cost, over the amount originally estimated, is necessary:

The original estimate, not including the lock and dam, was as follows (report of December 8, 1877):

From Breckenridge to Moorhead.....	\$22, 663 98
From Moorhead to Goose River.....	4, 428 00
From Goose River to Frog Point.....	32, 880 20
From Frog Point to boundary line.....	85, 338 00

Total..... 145, 310 18

The above amount, if applied to dredging alone, would pay for the excavation of 290,620 cubic yards, at 50 cents per cubic yard, the price estimated in 1877, and which was, I think, intended to include the cost of the plant, dredges, &c., necessary to do the work.

But though the cost of the total excavation thus far, including the cost of dredges,

&c., has proved to be about the same as originally estimated, the amount of excavation necessary to open the channel has far exceeded the estimate.

The deficiencies in the estimated amount necessary for the completion of the work occurs between Moorhead and Goose River and between Frog Point and boundary line.

From the beginning of the work in 1879 it has been necessary to dredge a channel through all of the principal bars from Moorhead to Goose River, and to this date 214,396 cubic yards have been removed and 60,000 cubic yards more will require removal to continue a 3-foot low-water channel to the latter point. The estimated cost of this work is, when completed, \$41,159.50.

The original estimate on the section of the river above referred to was \$4,428 for the removal of snags, overhanging trees, and mud lumps, the necessity for heavy channel dredging being evidently overlooked.

The work from Frog Point to the boundary line was originally estimated at 155,000 cubic yards. During the season of 1882, 47,342 cubic yards were removed, and I am satisfied from comparison of the work done, with that remaining to be done, that at least 200,000 cubic yards of material must be removed to complete that section of the river, an increase over the original estimate of about 100,000 cubic yards.

ESTIMATE OF THE AMOUNT REQUIRED TO COMPLETE THE IMPROVEMENT.

	Cubic yards.
Breckenridge to Moorhead (dredging)	40,000
Moorhead at Goose Rapids (dredging)	60,000
Goose River to Frog Point (dredging)	53,887
Frog Point to boundary line (dredging)	200,000
Total	353,887

The above, at present prices for labor, supplies, wood, &c., can be done for 20 cents per cubic yard, or a total of..... \$70,777 40

Amount available June 30, 1883..... \$4,504 02

To be appropriated, based upon estimate of December 8, 1877. 32,310 18

36,814 20

Additional amount over former estimate necessary to complete the work. 33,963 20

Very respectfully, your obedient servant,

R. DAVENPORT,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS, RED RIVER OF THE NORTH, BETWEEN BRECKENRIDGE AND THE BOUNDARY LINE, SEASON OF 1882.

There are at present three steamboat lines operating on the river, employing four steamboats and twenty barges.

The following is an accurate statement of the amount of freight moved by the different lines in 1882:

Lines, etc.	Carried down-stream.	Carried up-stream.	Character.
BETWEEN MOORHEAD AND PEMBINA.	<i>Pounds.</i>	<i>Pounds.</i>	
Alsop line.....	17,273,390	3,739,331	Merchandise, wheat, lumber, and wood.
Flat-boats and rafts.....	7,068,666		Merchandise and lumber.
Grandin line.....	8,928,881	18,855,245	Merchandise, wheat, and wood.
Red River Transportation Company.....	1,177,760	7,800,000	Merchandise, wheat, lumber, and wood.
BETWEEN MOORHEAD AND ABERCROMBIE.			
Alsop line.....	3,181,102	281,248	Wheat, merchandise, and lumber.
Total	32,627,799	30,875,824	

Of the above, 24,009,980 pounds were wheat. The river was open to navigation two hundred and twelve days.

The following comparative statement shows the increase in shipments of freight by river since the commencement of the improvement :

WHEAT, MERCHANDISE, LUMBER, AND WOOD.

	Pounds.
1882, total freight carried	63,303,629
1881, total freight carried	53,114,861
1880, total freight carried	43,301,515
1879, total freight carried	35,718,731
1878 and 1877, freight not given, but small in comparison with that of 1879.	

An average increase of over 9,000,000 pounds per year; of the above about 40 per cent. was wheat.

During the month of July 20,000,000 feet, B. M., of loose saw-logs were run down the river—8,000,000 from Ottertail River, and 12,000,000 from Red Lake. The logs occupied the river for about three weeks, and during that time the steamboats were compelled to lay up.

It is reported that the parties owning the timber lands on these rivers intend to continue running logs in the same manner in the future, and that the cut of each year hereafter will be largely increased. If this is allowed it will cause the entire suspension of navigation by steamboats for at least one month each season.

RED RIVER VALLEY—ITS EXTENT.

The extent of the region known as the Red River Valley is stated as about 225 miles east and west by 300 miles north and south. It contains approximately 67,500 square miles, or 43,200,000* acres of land, over 80 per cent. of which acreage comprise the finest farming land for the production of cereals and stock raising in the world; wheat, corn, oats, rye, barley, and flax are raised in abundant quantities and with less labor than in the older States and Territories.

X 9.

CONSTRUCTION OF LOCK AND DAM AT GOOSE RAPIDS, ON THE RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA.

This work was originally reported upon and an estimate of its cost submitted in December, 1877. Congress, by act approved March 3, 1881, appropriated the sum of \$20,000 towards the work, and by act passed August 2, 1882, made another appropriation of \$30,000 for it.

Examinations of the rapids were made during the fall and early part of the winter at several points in order to fix upon a locality at which a single lock and dam would prove of most benefit. The sum of the two appropriations is too small in proportion to the estimated cost (which it is now apparent will not be short of \$250,000) to admit of the making a beginning on this work.

It is proposed to submit a report in detail and estimate of cost in time for the next Congress. Should the work be commenced, the sum of \$100,000, in addition to the sums already appropriated, can be profitably expended during the fiscal year ending June 30, 1885.

The amount expended during the year ending June 30, 1883, is \$595.24, which represents also the *total* amount expended to June 30, 1883.

The Red River of the North is within the collection district of Minnesota, with Saint Vincent the port of entry. The amount of duties collected at Pembina and Saint Vincent during the fiscal year ending June 30, 1883, was \$28,993.99.

For commercial statistics of the Red River between boundary line and Abercrombie, Dak., see Annual Report, for improvement of the Red River of the North, Minnesota and Dakota.

* In the Annual Reports for 1881 and 1882 the number of acres was given as 259,200,000. The amount should have been stated as 43,200,000 acres.

ABSTRACT OF APPROPRIATIONS MADE FOR CONSTRUCTION OF LOCK AND DAM AT GOOSE RAPIDS, ON THE RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA.

By act March 3, 1881	\$20,000
By act August 2, 1882	30,000
Total	50,000

Money statement.

July 1, 1882, amount available	\$20,000 00
Amount appropriated by act passed August 2, 1882	30,000 00
	<hr/> 50,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	595 24
	<hr/> 49,404 76
July 1, 1883, amount available	
Amount (estimated) required for completion of project, per revised estimate	200,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	100,000 00

X 10.

RESERVOIRS UPON THE HEADWATERS OF THE MISSISSIPPI RIVER AND ITS TRIBUTARIES.

The object of the reservoirs is to collect surplus water, principally the precipitation of winter, spring, and early summer to be systematically released so as to benefit navigation upon the reaches of the several streams below the dams and also that of the Mississippi below Saint Paul. Alleviation of effects of floods, in localities near the proposed reservoirs, expected to obtain to some extent, but control of extended floods or freshets covering long reaches of river not expected. In order that navigation may be benefited upon the Mississippi above the mouth of the Saint Croix, upon the Saint Croix, the Chippewa, and the navigable reaches of the Wisconsin, the system of dams proposed for each must be carried out; and no benefit of consequence to the Mississippi below Lake Pepin can be predicted unless the entire system is carried out. For discussion of the capacities of, and supply to, these proposed reservoirs, reference is made to the several reports upon reservoir surveys of January 15, 1879, December 12, 1879, January 15, 1880, and January 16, 1881. In addition to appropriations previously made, Congress, by act passed August 2, 1882, appropriated the sum of \$300,000, for continuing operations.

During the fiscal year work has continued upon the dam at Lake Winnibigoshish, and that upon the Leech Lake and Pokegama Dams commenced.

The Winnibigoshish Dam, with lift of 14 feet and to create a reservoir of 45,000,000,000 cubic feet capacity, has been about two-thirds completed.

This dam is to have twenty-four sluices, each 20 square feet in cross-section, and a log-sluice 6 feet wide. The plan of embankment, approved by letter of the Chief of Engineers, March 30, 1882, provides for its top being 6 feet above the surface of highest water in the reservoir, width of embankment at top to be 10 feet, with two-fold slopes, diaphragm of timber, and slopes protected with riprap of stone. This

plan of embankment, together with plan of dam, was submitted for consideration of a Board of Engineers reconvened September 7, by Special Orders No. 78, Headquarters Corps of Engineers, 1882. Board deemed no increase in strength necessary.

The estimated cost of this dam, together with the necessary d to prevent flanking, is placed at \$160,000.

LEECH LAKE DAM.

This dam is to consist of piles, timber, and gravel and clay fill to be about 3,500 feet long, raising the level of Leech Lake 4 feet, and create a reservoir of 22,000,000,000 cubic feet capacity. Work upon commenced in September, 1882, and has continued to date, most of piling having been driven from the ice during February and March 1883. By the close of the fiscal year the round piling had all driven and one-third of the sheet-piling for the main dam, thus completing about half of the work.

The cost of this work is placed at \$80,000.

DAM AT POKEGAMA FALLS.

This work is to consist of crib-work, weighted with stone, and provided with thirty sluices, each having 20 square feet of cross section, in addition to which will be the necessary number of log sluices. A way over the dam is also provided for. The lift of dam to be 7 feet, the resulting reservoir to have a capacity of 3,500,000,000 cubic feet. The cost is placed at \$50,000.

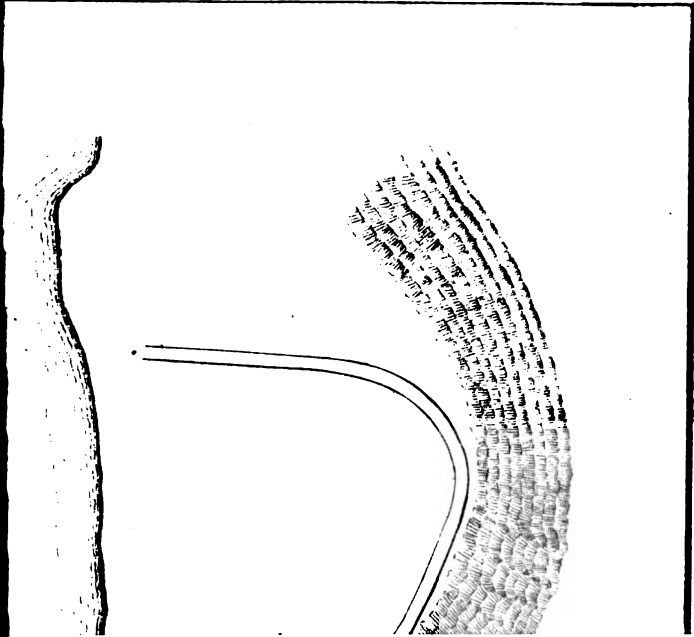
Owing to vexatious delays in obtaining releases against damages expected from overflow from the construction of this dam, work upon was not authorized until April 26, 1882. Advertisement was made inviting proposals for 1,069,552 feet, B. M., of saw-logs, to be delivered to the boom above the falls of Pokegama; but one bid was received, and the price being regarded as exorbitant, it was rejected and steps taken to procure logs by purchase and by day labor; 400,000 feet, B. M., have been obtained by the close of the fiscal year, and supplies, tools, saw mill and other machinery shipped to Aitken, to be conveyed up the Mississippi to the dam-site. Transportation of freight has been much delayed from the obstruction of the river by loose saw-logs.

The work on all these dams has been done by day labor and purchase of material in open market.

Mr. Charles Wanzer, assistant engineer in local charge, whose report of operations up to June 1 is herewith, and Messrs. Albert Wanzer and John Cullen, in immediate charge at Winnibigoshish and Leech lake are entitled to credit for energy and zeal displayed in carrying out the work intrusted to them.

A project for the proposed reservoir dam below the Vermillion River was submitted to the Department in December, 1882, the dam to cost about \$130,000. A large amount of Indian land will be overflowed by the operation of this dam, and probably nothing can be done toward its construction until the damages can be settled by the Department of the Interior.

Other work consisted in working up maps, plans, and data, and in classifying and obtaining releases for lands liable to overflow. The latter, a very tedious work, has been in charge of Mr. C. McClellan, assistant engineer.



It is proposed, with the balance of funds from appropriations to date, to push the work on the dams already commenced as vigorously as possible, and to commence work upon the proposed dam below the mouth of the Vermillion River as soon as the question of damage to Indian land can be settled. It is expected that the accumulation of water in the Winnibigoshish and Leech Lake reservoirs will begin during the latter part of the coming autumn.

In addition to the usual meteorological and hydrometrical observations, the three gauging-stations established on the Mississippi River above the Crow Wing River, on the Crow Wing, just above its junction with the Mississippi, and on the Saint Croix River, above Taylor's Falls, were continued; the latter until December, 1882, the others until November of that year; when, a year's daily observations at each having been obtained, the stations were discontinued. This work was under immediate charge of Mr. John B. Parkinson, assistant engineer, whose interesting report of February 3, 1883, is herewith.

The observations at these stations were for the purpose of ascertaining more closely than had previously been ascertained the proportion of the precipitation—rain and melted snow—that actually found its way into the streams; that is, the available monthly and annual precipitation. The results are for one year, and although the conditions affecting precipitation and drainage may not be the same for any two consecutive years, nor for a number of years, a great increase in knowledge of this proportion has been gained; although, in order to further meet questions of riparian rights that may arise upon the Mississippi, a year's observations, at least, should be made at or below Pokegama Falls.

The necessity for these observations was foreseen at an early stage of the examinations and investigations begun in 1878, as the question of a compensating reservoir, or compensating reservoirs, from which to replace water abstracted from the streams at certain seasons, might at any time arise on the part of owners of water-power which had been developed and in actual use for a number of years. This matter of compensation, if recognized, will depend as to adjustment upon the basis upon which the power is computed; that is, whether upon the basis of a winter-flow or upon that of some other stage of water. Operation of the reservoirs wholly in the interest of navigation will not probably at all times meet the views of mill-owners or the log-driving interests. Experience, as the investigations have progressed, has made this evident. It may be questioned, however, whether impounding water in reservoirs 300 to 400 miles from a water-power can be objected to.

From a study of the results of the observations at the three gauging stations, and of those made previously, the following is deduced; the figures representing the available quantity of water being taken on the side of safety; that is, giving the reservoirs the disadvantage of doubts:

The area of basin tributary to the Mississippi River above the mouth of the Crow Wing is 7,283 square miles. The total quantity of water passing the station for the year, November, 1881, to November, 1882, was, as measured, 151,644,239,424 cubic feet, corresponding to depth of available precipitation over the entire basin of 0.746 foot. In this basin are a number of lakes whose areas aggregate approximately 803 square miles. If we assume that the annual evaporation from these lakes equals the total annual precipitation over their areas, that is, throw the lake area out entirely, we have 6,480 square miles which, reduced to square feet and divided into the total quantity of water, gives 0.839 foot, or more than 10 inches as the available depth over the really available basin.

The precipitation for the year at four of the principal meteorological stations in and near to this basin was at—

	Inches.
Crow Wing.....	33.02
Leech Lake.....	27.84
Moorhead.....	31.71
Duluth.....	34.03
Total.....	130.60
Mean.....	32.65

Throwing out the large items of rainfall at Moorhead and Duluth, as these stations are not actually within the basin under discussion, and taking the mean of the precipitation at Crow Wing and Leech Lake we have 30.43 inches \pm 2.52 feet. Comparing this with available precipitation under the two cases, viz, water-shed including the lake area, and, excluding it, we have the ratios, 0.296 and 0.333, respectively.

The area of water-shed tributary to the station on the Crow Wing River is 3,576 square miles. The depth of available precipitation for this area was 1.019. The lake area within this basin is approximately 196 square miles. Subtracting this lake area we have 3,380 square miles and corresponding available depth 1,078 feet. Ratios, 0.404 and 0.428, respectively.

The area of water-shed tributary to the station on the Saint Croix is 5,950 square miles. The lake area within the basin is about 170 square miles, which, subtracted from the foregoing, leaves 5,780 square miles. The average precipitation over the water-shed for the year December, 1881, to December, 1882, is taken at 32.58 inches = 2.7 feet. It is undoubtedly larger. The depth of available precipitation over the entire basin was 1.365 feet for the area including the lakes, and 1.395 feet for the area excluding the lakes. This distinction as to ratios is, it may be observed, of value when portions only of the basins come to be considered. The ratios are 0.499 and 0.513, respectively.

It will be seen that there is a marked difference in the values of available precipitation in each of the three basins. The basin of the Mississippi above the mouth of the Crow Wing has, as characteristic features, areas of swamp on a scale exceeding anything in the Crow Wing or Saint Croix basins. The slopes of the first named are slight, the minor streams tolerably sluggish, and marsh and vegetation abound. In the Saint Croix Basin, on the other hand, the slopes are sharp, streams generally rapid, and the geological formation generally more favorable to rapid drainage.

The later observations could not be extended to include the sources of the Chippewa and Wisconsin rivers. Meteorological observations taken for three consecutive years at Wausau, at the sources of the Wisconsin River, gave, as the annual precipitation, the following:

	Inches.
For 1879.....	32.48
For 1880.....	38.61
For 1881.....	47.63

The reservoirs proposed for the Mississippi above Saint Paul will furnish a quantity of water equivalent to 5,500 to 6,000 cubic feet per second for a period of ninety days. During seasons of unusual rainfall a larger quantity can be calculated upon. The lowest discharge of the Mississippi at Saint Paul during the navigation period is about 5,800 cubic feet per second. Adding the 5,500 cubic feet we have 11,300 cubic feet to pass Saint Paul during the time when, without the increment, the river would be at its lowest stage. But this lowest discharge, viz, 5,800 cubic feet, very seldom obtains.

The low-water period generally covers part of July, all of August, part of September, and all of October. In the year 1875 the average discharge per second past Saint Paul was calculated as follows:

	Cubic feet.
For July	26, 609
For August	16, 231
For September	33, 157
For October	18, 794

Eighteen hundred and seventy-five was an unusual river year, and probably a good one for the storage of an extra supply of water.

Turning to 1879 we have, as averaging past Saint Paul, per second:

	Cubic feet.
For July	32, 983
For October	7, 040

It appears from the foregoing that a steady drain upon the reservoirs of 5,500 cubic feet per second for ninety days would probably never be necessary. The quantity would vary as occasion demanded.

As for the river above Minneapolis, the increment of 5,500 cubic feet would render unnecessary the greater part of the wing-dams, jetties, &c., projected in case the thorough improvement of that part of the river were ever undertaken.

For the Saint Croix River, the surplus water that can be impounded in reservoirs will furnish (and this is regarded as far below the actuality) 4,000 cubic feet per second for ninety days to add to the low-water discharge of 2,000 cubic feet. With a discharge of 4,000 cubic feet per second in the navigable Saint Croix, the needs of navigation are fully met.

The Chippewa River system will, it is calculated, furnish 2,800 cubic feet per second for ninety days to add to the low-water discharge of 2,600 to 3,000 cubic feet. With a discharge of 4,000 cubic feet per second in the navigable portion of the Chippewa, that is, the portion from the mouth to Eau Claire, the wants of navigation are met.

The Wisconsin River system will, it is calculated, furnish 2,300 cubic feet per second for a period of ninety days, to add to the low-water discharge of the stream.

The increments to the low-water discharge per second of the Mississippi from the four systems would be:

	Cubic feet.
Above the junction of the Mississippi and Saint Croix for ninety days	5, 500
Below the junction	9, 500
Below the mouth of the Chippewa	12, 300
Below the mouth of the Wisconsin	14, 600

The Chippewa River system will be more difficult of construction and operation than would that of the Mississippi, on account of the smaller capacities and greater number of reservoirs pertaining to the former.

Should two or more years of minimum rainfall occur in succession, the reservoir service would, of course, be reduced.

The estimated cost of the proposed system of reservoirs was (see Appendix W, Annual Report, 1881) \$1,809,083.50. This sum does not include the cost of damages from overflow or from outlet of water, items that cannot be stated in advance in the shape of dollars and cents, or more than approximately in acreage.

The sum of \$200,000 is estimated as the amount necessary, in addition to the sums already appropriated, for the completion of the system on the Mississippi River above Saint Paul, including the Pine and Gull River reservoirs, and can be profitably expended during the fiscal year ending June 30, 1885.

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The estimated cost of the Pine River system is, exclusive of land damages, &c., placed at \$124,158.09, as follows :

Cross Lake Dam and Dike	\$80, 158 09
Dam on the South Fork of Pine River	16, 000 00
Dam at Norway Lake	18, 000 00
Dam at Mountain Lake	10, 000 00

The dams of South Fork, Norway Lake, and at Mountain Lake, are to create supplemental reservoirs to hold what would be a surplus supply to the Cross Lake Reservoir. The latter being the most important, and by far the largest, should be the first one created.

The estimated cost, exclusive of that of damages, of the Gull Lake Reservoir is \$63,857.37.

Out of the appropriations to date have been paid the expense attendant upon examinations, tabulation, and investigation of lands liable to be damaged; cost of obtaining releases; expenses incurred in endeavoring to obtain right of way for commencement of work upon the Chipewa River system, 1881; and meteorological and hydrometrical investigations.

Commencement of work at and above the Falls of Pokegama has been facilitated by the voluntary waivers of claims by owners of private lands against damages from overflow or otherwise from the operations of the dams, and by the act of the Minnesota legislature, approved November 18, 1881, releasing the United States from all claims for damages for overflow of State lands from the construction and operation of reservoir dams.

A commission was appointed in November, 1882, by the Department of the Interior, to revise the award for damage to Indian lands made by the commission of 1881.

Owing to unforeseen difficulties in obtaining foundations for the Winnibigoshish Dam, by which the quantities of material had to be greatly increased, and the cost of cutting roads, the increase in prices of material, labor, &c., the work costs about 25 per cent. more than was anticipated.

The total amount expended to June 30, 1883 (including outstanding liabilities), is \$212,881.33.

Amounts appropriated to date are :

Act approved June 14, 1880	\$75, 000
Act approved March 3, 1881	150, 000
Act passed August 2, 1882	300, 000

Total	525, 000
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Allotment per letter from office Chief of Engineers, November 9, 1881....	\$1, 572 15
Allotment per letter from office Chief of Engineers, January 20, 1882	176 00
Award to Indians for damages in connection with the building of Lake Winnibigoshish Dam, letter from office Chief of Engineers, November 8, 1881	8, 393 30
Award to Indians for damages in connection with the building of Leech Lake Dam, letter from office Chief of Engineers, January 20, 1882	7, 073 60
Allotted for meteorological observations, borings, examinations, &c., letter from office of Chief of Engineers, May 27, 1881	7, 500 00
Amount available June 30, 1883	*312, 118 67

* It is not known at this writing whether the amounts awarded to Indians for damages in connection with the building of Lake Winnibigoshish Dam and Leech Lake Dam are to be paid from the appropriation for reservoirs. If so, then the amount available June 30, 1883, will be \$296,651.77.

Money statement.

July 1, 1882, amount available	\$140,713 05
Amount appropriated by act passed August 2, 1882	300,000 00
	<hr/> 440,713 05
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$114,082 76
July 1, 1883, outstanding liabilities.....	14,511 62
	<hr/> 128,594 38
July 1, 1883, amount available.....	312,118 67
	<hr/> 1,284,033 50
Amount (estimated) required for completion of existing project.....	1,284,033 50
Amount that can be profitably expended in fiscal year ending June 30, 1885.	200,000 00

Abstract of proposals opened May 10, 1883, by Maj. Charles J. Allen, Corps of Engineers, Saint Paul, Minn., for furnishing pine logs at the site of the reservoir dam at Pokegama Falls, on the Mississippi River.

[For furnishing 1,069,552 feet, B. M., white pine logs.]

No.	Name and residence of bidder.	Names and residence of sureties.	Price per M feet, B. M.
1	T. B. Walker, Minneapolis, Minn.....	Henry T. Wells and S. A. Harris, Minneapolis, Minn.	\$15 00

REMARKS.—Informal. No seal of wax or other adhesive substance affixed to signature of bidder. Same objection in regard to signatures on bidder's bond; one witness to signature on bidder's bond wanted; proposition as to price is excessive; interlineation in the proposal as to prices not in conformity with specifications. Bid rejected.

REPORT OF MR. CHARLES WANZER, ASSISTANT ENGINEER.

WINNIBIGOSHISH DAM, June 16, 1883.

MAJOR: The report of work done on the reservoirs at the headwaters of the Mississippi River during the last eleven months is hereby respectfully submitted.

Operations have consisted in the continuance of construction on Lake Winnibigoshish Dam and the inaugurating of work on the Leech Lake Dam and the dam at Pokegama Falls, on the Mississippi River.

FIRST.—WINNIBIGOSHISH DAM.

The work at this place has consisted in pile-driving for foundations and coffer-dams, building of barges, towing of logs across the lake, summer logging, sawing lumber, gathering and towing of stone for filling of cribs and for riprap to embankment, cutting of wood, excavating for foundations and to obtain clay, building of clay puddle-wall and earth embankment on main dam, together with such work as has been necessary in order to enable the above-enumerated works to progress.

During the season of 1882, and subsequent to June 30, the work experienced unavoidable delays, on account of the trouble in getting labor into this country. The Indian labor, on which much reliance was placed, fell off shortly after the beginning of the fiscal year, and the time occupied in getting new white labor to the work was considerable. The expense of transportation of laborers and teams was also large, and had to be borne by the Government, as I was unable to employ men who were willing to go 100 miles through the woods and over lakes to obtain work, unless their transportation was provided for. This season the works are better advertised and known, and the same amount of trouble is not experienced. Indian labor is also thus far proving much more advantageous than last season, and if success attends the efforts to prevent the importation of whiskey among them, I believe they will continue to be faithful laborers. But in any event, it is not calculated to rely too much on Indian services. As far as known to me, the Indians have no ill feeling toward the continuance of these works, but on the contrary, I believe that the great majority would deplore their suspension.

The matter of obtaining stone for riprap and filling of cribs is getting to be an expensive affair. There is but a small quantity of stone on the shores of this lake, and the greater bulk must be obtained from Cass Lake. This necessitates transportation and towing on barges down a very shallow and tortuous river, and then across the lake. A stone camp was started at Cass Lake on the 12th of May, and so far is working satisfactorily; but I fear interruption during the months of August, September, and October, on account of low water. Last season on October 21 I could not get the steamboat up that portion of the river on account of lack of depth of water.

The lack of good mail facilities has also somewhat retarded operations at this place. On September 26, 1882, the absence of an unbroken stratum of clay under the proposed timber-slucies was discovered, which somewhat changed the plans of the foundation, and it was not until November 3, 1882, that I received your orders giving authority to proceed under the new plans. This delay brought us into the winter weather before actual driving of foundations could be commenced. On October 2, 1882, the coffer-dam for the timber work was pumped out, and excavating for foundations was commenced next day. A diagram* showing the thickness of clay stratum at the different borings is hereto annexed, and on the same diagram is indicated the sheet-piling to be driven to insure safety from undermining of the timber work.

Excavation in this coffer-dam continued until cold weather prevented. Pile-driving in this coffer-dam commenced November 9, 1882, and stopped for the season on December 7, 1882.

Labor on clay puddle-wall and embankment was continued during the season until prevented by the weather.

I found it unsafe to continue building of puddle-wall later than November 13. Work on embankment proper continued until the 29th of the same month. Timber work might have been continued later, but for the fact that it was found to be impracticable to properly fill in under the floor of the sluices between the caps. The material used was clay, and was so full of frost and ice lumps that it could not be safely used as filling, on account of subsequent settlement leaving a direct channel for water under the entire structure.

The steamer was laid up for the winter on October 30, 1882.

First snow came on October 17, 1882.

On stoppage of timber and earthwork a large number of laborers were discharged, and what were needed were removed to Leach Lake, to work on that dam.

The work for the winter at this place consisted principally in hauling out and repairing the steamboat, the cutting and banking of piles, the hauling of supplies, the sawing of lumber, and cutting of cordwood. The work on the steamboat was thoroughly done.

The sawing of lumber was completed February 10, 1883, and the mill was immediately dismantled, and as soon as possible sent over to Leech Lake Dam, to do the sawing for that work.

The winter proved to be a very cold one, and consequently all operations went slowly. The thermometer at one time indicating 50 degrees below zero (January 22, 1883), and for many days ranged at or below 40 degrees below zero.

On February 2, 1883, small-pox appeared among the Indians at this place, and all of them in the Government employ were discharged and quarantined against it. No one from the east side of the river was allowed to come over to our camps, nor was any one allowed to mingle with any straggling body of natives. There were twenty-six deaths among the Indians immediately bordering on our works. But no case occurred among the whites in our employ, nor were buildings or material in any way infected by the disease. To Dr. James R. Walker much credit is due for sound advice in quarantining against the infection.

The work for the season of 1883 commenced on April 1, and a new importation of white labor commenced arriving on that date. Excavation for puddle-wall foundation commenced April 3, and the actual building of clay puddle began on April 19, and has since continued without interruption. Embankment for main dam commenced on the same date. The coffer-dam for timber-slucies was pumped out on April 17, and was found in perfect order, after being subjected to the ice and frost of the severe winter.

The last snow-storm for the season occurred on the first day of May, and the ice went out of the lakes on May 7, and navigation of the lake by steamboat was opened on the 8th. On May 12, 1883, the stone camp on Cass Lake was started, and the gathering and barging of stone from that point is now in progress.

Both pile-drivers having worked during the winter at Leech Lake Dam, it was the 11th of May before one of them could be transported by barge from that place. Pile-driving for foundation in the timber coffer-dam commenced May 14, and is now going on and will continue until completed.

It is expected that by August 15 next, all the sluices will be built and all the waste-

* Diagram omitted.

ways and piers carried above low water. As soon as that is accomplished, the coffer dam will be torn out, and the river turned back into its original channel and through the sluices; two drivers will then work at closing up the present channel, and the building of the final section of earth embankment, and puddle-wall be commenced, and as soon as this portion of the work is raised safely above the level of the water, the gates can be shut down, and the process of accumulating water in the reservoir can be commenced.

While waiting for the timber work to be raised to the proper height, there will be a delay in the building of the embankment, and at that time, all spare labor will be directed towards the building of the necessary dikes near the Portage, between this lake and Leech Lake.

Below is given the amount and cost of the principal kinds of work done during the year, from which it will be seen that the unit of cost is not generally in excess of the estimates.

The increased cost of this work over the estimates is due to the large excess of work found necessary to be done. This is owing in a great measure to the amount of excavation necessary to reach clay foundation and to remove porous and muck material. This increases the embankment and clay puddle-wall in a corresponding ratio and the increased depth of excavation demands much more expensive coffer-damming than was anticipated.

The above work has been under the constant personal supervision of Albert Wanzer as overseer.

QUANTITIES AND COST.

The number of men's rations furnished from the beginning of work on the dam to June 30, 1883, will be 45,345. First cost of rations, 37.4 cents per ration. Cost, including transportation, 44.9 cents per ration.

The number of horse rations furnished from the beginning of the work to June 30, 1883, will be 10,046. Cost, not including transportation, 56½ cents per horse ration. Cost, including transportation, 79 cents per horse ration.

Number round piles driven from June 30, 1882, to May 31, 1883, 629; number sheet-piles driven from June 30, 1882, to May 31, 1883, 2,074; total number of piles driven, 2,703.

Total cost of driving, including the building of drivers, repairs, rations, superintendence, and proportional cost of general expenses, \$5,294.44. Cost per pile, \$1.96; cost per linear foot 9 cents.

Number feet lumber sawed, B. M., 1,252,227 feet. Cost, including piling of lumber, superintendence, rations, &c., \$4,368.23; cost per thousand feet, B. M., \$3.48.

Number bushels of charcoal burned, 953; cost \$125.58; cost per bushel for burning, only 13.3 cents.

Number of barges built were five; sizes as follows: three barges 16 by 80 feet; one barge 20 by 40 feet; one barge 10 by 55 feet. Total cost of five barges, \$1,303.18.

Additional quarters and storehouses and repairs, \$618.08.

Expense, labor running steamboat from June 30, 1882, to May 31, 1883, including rations, &c., \$2,312.96.

Pumping, building frames, and bailing cost \$1,794.67.

Number cords of wood cut and piled, 1,007; cost, including delivery to steamboat, pumps, and pile-drivers, \$3,022.98; cost per cord, \$3.

Number cubic yards of stone gathered, loaded, and unloaded, and towed on barges to the work, 925; cost, including time of steamboat, \$3,050.42; cost per yard, \$3.30.

Number feet of logs towed across the lake (16 miles), 591,814 feet, B. M.; cost, including steamboat services, \$676.87; cost per thousand feet, B. M., \$1.14.4.

Number feet, B. M., of timber placed in sluices, 91,352; cost, \$861.65; cost per thousand feet, B. M., \$9.43.

NOTE.—This consisted principally of capping under the bottom floor. The superstructure will go together at much less cost.

Number of feet, B. M., of timber pulled out of the river and piled at the works, 1,042,000; cost, \$913.40; cost per thousand feet, B. M., 87.6 cents.

Number feet of logs, B. M., cut and banked (summer hauling), 281,031 feet; cost, \$1,987.95; cost per thousand feet, B. M., \$7.07.3.

Number of round piles cut and banked, 514; cost, including driving and pulling out of water, \$448.28; cost per pile, 87.6 cents.

Number of tons of ice harvested, 75; cost, \$108.45; cost per ton, \$1.45.

Transportation via Brainerd and Leech Lake; number of pounds hauled, including 8,800 pounds hauled from this place to Leech Lake Dam, 303,729 pounds.

Excavation: Stripping to obtain clay for puddle-wall, 8,700 cubic yards; cost, \$2,436; cost per cubic yard, 28 cents.

Excavation of foundations, 29,977 cubic yards; cost, \$9,292.87; cost per cubic yard, 31 cents.

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Embankment in dam proper, and around coffer-dams, 33,174 cubic yards; cost, \$4,976.10; cost per cubic yard, 15 cents.

Clay puddle-wall built, 4,769 cubic yards; cost, including excavating from the pit, transportation and puddling in the wall, \$3,774.96; cost per cubic yard in the wall, \$1.84.

Number linear feet of diaphragm placed, 506; cost, \$759; cost per linear foot, \$1.50.

Number linear feet of boom-timber made for Pokegama Dam, 3,000 feet; cost, including boom-chains and driving to Pokegama Dam, \$874.11.

NOTE.—To the above items, in ascertaining the price per unit, first cost per ration of men and teams is added, also the proper proportion of general expenses, including cook hire, superintendence, blacksmithing, watchmen, and other incidentals.

Transportation is not added, but is kept as a separate item.

The amount of plant on hand cost \$22,445.71; the amount of material on hand, including lumber purchased, boat spikes and nails, line, &c., \$3,432.24.

SECOND.—LEECH LAKE DAM.

The work on this dam was inaugurated in September, 1882, and under the personal supervision of Mr. John Cullen, assistant engineer.

The work has consisted of building of quarters for men and teams, the hauling of supplies for both summer and winter use, the cutting, banking, and towing of logs to the mill, the cutting, hauling, and driving of piles and sheet piles, the building and operation of saw-mill, the cutting of cord-wood and clearing of land for the purpose of obtaining earth for embankment, the excavation of top surface of core of dam, the building of the necessary bridges and roads, and the capping of piles.

The lumber for building of the cook-house, office, sleeping quarters, warehouse, and blacksmith shop was obtained from the mill at Winnibigoshish, and the buildings were erected in the fall of 1882. The erection of buildings was commenced October 9, 1882. The balance of the buildings are made of logs and covered with a board roof.

The principal amount of logs cut for this work was obtained from the north side of Leech Lake, about 4 miles distant from the entrance to Leech Lake River.

The cutting of logging-roads was commenced November 9, 1882. The buildings at the logging camp were completed December 30, 1882, and the actual cutting of logs commenced January 1, 1883.

The expense of obtaining these logs was more than anticipated, and the increased cost was mostly due to the great depth of snow and extreme cold weather.

A more advantageous location for simply cutting and banking the logs might have been selected, but after the experience in towing across Winnibigoshish Lake during 1882 it was deemed better to locate the camps as near to the dam as possible, so as to avoid the winds in towing across the lake. These logs were towed across the lake to the dam during the month of May, and driven to the mill.

The necessary number of piles was found on the reservation near the dam-site. They were hauled directly to the work.

The timber for the foundation of the saw-mill was hewn out in the woods and hauled to the site. The mill is built on a pile foundation, in the same manner as was done at Lake Winnibigoshish, and the machinery and mill were brought here from the latter place after the completion of its work for that dam. The last of the machinery arrived at the work on March 21, and the mill commenced sawing on April 10, 1883, and has worked in a very satisfactory manner.

Pile-driving on the dam proper commenced February 19, 1883, and was continued during the winter.

The banks of the river at this place are about 3,500 feet apart, and a soft marsh occupies this entire space, with the exception of the river channel. This marsh is in summer very soft and wet, while during the winter months it afforded a perfectly level and advantageous place to drive piles. All the piles across this marsh were driven before the frost was out of the swamp in the spring.

The sheet-piling for this work is now being driven across the marsh, the driver being worked on caps placed on the piles driven during the winter. The sheet-piling is driven at least 4 feet into solid material, principally clay, the surface above the clay being a soft muck and sand. The tops of the sheet-piles are left standing 4 feet above the proposed flowage line in the reservoir. One driver only is at present working at this place, but by August 1 another driver will be at work, and by September 1 next it is expected to have three drivers doing this sheet-piling. The entire distance requiring sheet-piling, including coffer-dam for the timber-slucies, will be something over 6,500 linear feet, and all three drivers will be necessary to complete the driving this season. On account of the extremely long distance that earth has to be hauled for the embankment portion of the dam, patent dump-cars have been purchased, which will be worked on a portable track.

The total amounts of work done since the commencing of this dam to date are given below, with the cost per unit of each class of work.

Number of linear feet of bridging across river and marsh, along the line of the dam, 2,210; cost, including rations of men and teams, \$794.43; cost per linear foot, 36 cents.

Number of feet, B. M., of timber placed in the work to date, 52,801; cost, \$717.99; cost per thousand feet, B. M., \$13.60.

Cost of building saw-mill, including the expenses of engineer and superintendence, \$1,325.20.

Number of feet, B. M., lumber sawed, 597,629; cost, \$1,571.77; cost per thousand feet, B. M., \$2.65.

Number of feet, B. M., of logs cut and hauled on north side of Leech Lake during the winter, 1,323,567; cost, \$6,018; cost per thousand feet, B. M., \$4.54½.

Cost of towing the above logs and driving to the mill, \$793.99; cost per thousand feet, B. M., 60 cents.

Number of feet, B. M., of logs cut near the dam-site, 171,943; cost, \$878.69; cost per thousand feet, B. M., \$5.11. Number linear feet of round Norway piles, cut and hauled to dam, 44,056; cost, \$1,157.53; cost per linear foot, 2½ cents.

Number linear feet of round piles already driven in dam, 35,189; cost of driving, \$3,918.17; cost per linear foot, 11½ cents.

Number linear feet of sheet-piling driven in dam 15,688 = 93,136 feet B. M.; cost of driving, \$1,034.49; cost per linear foot, 6½ cents.

Number of buildings erected for quarters, office, stable, &c., 10; cost, including nails and fixtures, \$2,333.29.

Number acres cleared, where earth for embankment is to be obtained, 4½; cost of clearing, \$146.46; cost per acre, \$35.30.

Number cords wood cut, 390; cost, \$697.15; cost per cord, \$1.79.

Number of tons of ice harvested, 150; cost, \$182.47; cost per ton, \$1.21½.

Number cubic yards of excavation of marsh, for core of embankment, 222; cost, \$56.34; cost per cubic yard, 25½ cents.

Number bushels charcoal burned, 467½; cost, including wood and labor, \$175.52; cost per bushel, 37½ cents.

General expenses to be charged to dam, but not included in above items, \$2,133.17.

Superintendence, not included in cost of above items of work, \$1,830.

In computing the above units of cost, the labor and the cost of rations (both men and teams) are included.

The work is now progressing favorably and earth embankment will be commenced at once. In inaugurating the operations on this dam great benefit has been derived from the fact of having had the works at Lake Winnibigoshish already in operation, thus affording a starting point from which to act, and the plant purchased for the latter work can be made available, as has already been done, in starting any new work in this section of the country.

THIRD.—POKEGAMA DAM.

No actual construction has as yet taken place. The lumber for the buildings is now being obtained and supplies and plant have already been ordered for the work; 400,000 feet, B. M., of logs have been purchased to be driven into the boom, located above the site of the mill. Sawing of this lumber will commence as soon as the saw-mill is set up, and from that time on, actual construction will proceed rapidly. It was hoped that the purchase of a saw-mill for this work could be avoided, by using the one at present at Leech Lake Dam. But it was found that the sawing at that place could not be completed until too late to be of service.

This work is under the superintendence of Mr. J. B. Parkinson, as overseer.

Very respectfully, your obedient servant,

CHAS. WANZER,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

EXTRACTS FROM REPORT OF MR. J. B. PARKINSON, ASSISTANT ENGINEER.

SAINT PAUL, MINN., February 23, 1883.

SIR: I have the honor to submit herewith a report on the hydrological and meteorological observations carried on during the past year at Crow Wing, Minn., and above Taylor's Falls, Minn., together with a summary of results obtained and some miscellaneous data of interest.

The observing stations selected were three in number, the first two being on the Mississippi River at its point of junction with the Crow Wing River, where one sec-

tion was selected about 1,200 feet above the junction on the Mississippi, and the other about 1 mile up stream on the Crow Wing. The third station was established on the Saint Croix River about 7 miles above Taylor's Falls, and at the head of a rapid extending down the river to the latter place.

The methods of observation employed at each of these stations were identical, and were as follows: A wire rope of the necessary length was stretched across the river after being carefully measured and marked with tin tags at intervals of 25 feet.

The observation was then taken by sounding at each tag, measuring from the nearest tag on each side to the edge of the water, and placing a current-meter at mid-depth at each tag and recording the velocity.

The meter used was a simple one of Mr. Frizell's invention, and recorded by means of a small peg set in the shaft, which in revolving was made to slide up a slight inclined surface and then drop about one-tenth of an inch, the drop causing a sharp click plainly audible at the surface, the sound being transmitted by means of the hollow brass rod to which the meter was clamped. The method pursued was for the observer, with timer in hand, to count one hundred revolutions and take the exact time. From the ratings of the meter already taken, and described further on, a table giving the velocity corresponding to each time of one hundred revolutions was constructed. This table included each half second within the limits of possible observation, and the number of seconds per one hundred revolutions being given, the velocity could be written down at once.

In winter, when the river was covered with ice, the manner of observing was essentially the same, except that three observations were taken: one a foot above the bottom, one at mid-depth, and one a foot below the under surface of the ice. The thickness of the ice at each station was also measured daily.

A small shelter-house on runners, with a trap-door in the floor and a small stove, was also provided, as it was found to be impracticable to take observations unprotected at very low temperatures, the meter freezing instantly on being removed from the water.

By means of the house, however, which could be pushed directly over the holes, this trouble was mostly obviated, and, when occurring, a supply of hot water was always at hand to thaw the meter.

In connection with the gaugings, a record of the height of the water was taken three times a day, as were also the records of precipitation and evaporation, the latter covering about seven of the warmer months, from April to November.

One observer was employed at each station, with such temporary help as might be necessary in any emergency.

The observations began at Crow Wing November 3, 1881, and on the Saint Croix December 6, 1881, and were carried on for one year.

Early in January, 1882, I was placed in charge of the observations, and have continued to have personal direction of them since that date.

The continuity of the observations during the year has several times been broken by accidents to the meters, high water, running ice, logs, &c., but by keeping up the gauge readings, and taking soundings when practicable, it was possible to arrive at approximations for the missing observations, sufficiently close to the truth to enable me to say with confidence that any errors arising from these approximations are insignificant in relation to the final result: i. e., the depth of water over the basin, which has entered the river. The same may be said of quite a long period during the winter at the Saint Croix station, where "mush-ice" prevented observations at several points in the middle of the section, causing much trouble to arrive at the real discharge.

It was found, however, that even if that portion of the section obstructed were thrown out during the entire period it would hardly be appreciable when measured as depth over the basin. In May, 1882, very thorough ratings of the meters were taken, and new tables constructed from them.

These tables, though differing somewhat from those employed during the winter, were found when applied to the gaugings during that period to give difference of not more than 2 or 3 per cent. of the discharge. These differences were corrected in the final summary, it having been assumed that the later ratings were more nearly correct, as they were taken under much more favorable circumstances and covered a much greater range of velocities. These two sets of tables were constructed on different plans, the former assuming the effect of friction in the meter to be a constant, the latter using it as a variable deduced from actual observation, and exerting a much greater retarding influence on the wheel during low velocities than during high ones.

Before proceeding to give the detailed results it may be said that the series of observations taken, though by no means perfect, and though frequently interrupted and carried on often under disadvantages, are, as a whole, a very valuable addition to the hydrological data of the office.

One cause of delay and trouble was the construction of the meters, which in some

parts were hardly strong enough to stand the continuous strain of so long a series of observations.

These defects, however, are easily remedied and in no way affect the value of the meter, which is, on the whole, the simplest and most effective machine for the purpose that I know of. In its present form its use would be restricted, however, to streams of not much greater depth or rapidity than those in which it has been used.

The meter could easily be altered by changing the pitch of the blades so as to register a much higher velocity.

Having thus given a general review of the progress of the work and the methods employed, we will now pass to a detailed account of the results obtained, which may be conveniently divided into two sections:

First. *Hydrological*; embracing the record of discharge, and the deductions drawn from them, together with such phenomena of interest as were noted in that connection.

Second. *Meteorological*; embracing the records of (1) Precipitation, and (2) Evaporation.

First. HYDROLOGICAL.

Under this head we will consider—

- (a) Mississippi River.
- (b) Crow Wing River.
- (c) Saint Croix River.

(a) *Mississippi River*.—Below is presented a summary, by months, of the discharges in feet per second, together with the total quantity of water, and its amount measured in depth over the basin.

Mississippi River, area of basin 7,283 square miles.

Month.	Sum of discharges per second.	Average approximate daily discharge per second.	Total quantity of water passing.	Depth over basin.
	<i>Cubic feet.</i>	<i>Cubic feet.</i>	<i>Cubic feet.</i>	<i>Feet.</i>
November,* 1881.....	132,985.82	4,700	11,489,974,848	0.057
December, 1881.....	108,577.79	3,500	9,381,121,056	0.045
January, 1882.....	75,006.72	2,400	6,480,580,608	0.032
February, 1882.....	55,896.34	2,000	4,829,443,776	0.024
March, 1882.....	65,372.28	2,100	5,848,164,992	0.028
April, 1882.....	197,629.55	6,600	17,075,193,120	0.084
May, 1882.....	295,763.57	9,500	25,533,972,448	0.125
June, 1882.....	262,396.58	8,700	22,670,200,512	0.112
July, 1882.....	238,960.83	7,700	20,646,215,712	0.102
August, 1882.....	123,452.02	4,000	10,666,254,528	0.052
September, 1882.....	87,794.04	2,900	7,585,405,056	0.037
October,† 1882.....	111,316.12	3,400	9,617,712,768	0.048
Sums.....	1,758,141.66	57,500	151,644,239,424	0.746
Means.....	146,261.80	4,791	12,637,019,952	0.062

* 28 days.

† 33 days.

An examination of this table shows that the total quantity of water passing Crow Wing during the year, expressed in depth over the basin, was 0.746 foot, or nearly 9 inches.

In this basin there are an immense number of lakes, and the evaporation from their surfaces is usually taken to be at least equal to the annual precipitation. For the sake of comparison the area of these lakes has been computed and found to approximately equal 803 square miles, or 0.110 of the total area, 7,283 square miles. Subtracting the lake area from the basin we have as a remainder 6,480 square miles. This quantity reduced to square feet and divided into the total quantity of water gives 0.839 foot, or over 10 inches, as the depth over the really available basin.

In order to compare these figures with the average precipitation over the basin, four stations have been selected where observations were taken during this period.

1. Crow Wing, at the southern boundary.
2. Leech Lake, near the center.
3. Moorhead, about 100 miles west of the basin.
4. Duluth, about 50 miles east of the basin.

The two former were under the direction of this office, the latter being stations of the United States Signal Service.

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The following are the records of these stations:

	Inches.
Crow Wing.....	33.02
Leech Lake.....	27.84
Moorhead.....	31.71
Duluth.....	38.03
Total.....	130.60
Mean.....	32.65

The mean of the two stations within the basin, Crow Wing and Leech Lake, would be 30.43 inches; but as there is reason to believe that the observations at the latter station are not entirely reliable and that some have been omitted, making the total too small, I have considered that the mean of the four stations would be nearer the truth.

Assuming this to be correct, we have the depths 0.746 and 0.839 foot to compare with the total precipitation, 2.720 feet, which give the ratios 0.274 and 0.308 respectively; or, the quantity of water passing in the Mississippi River above its junction with the Crow Wing from November 3, 1881, to November 3, 1882, was less than one-third the total precipitation during that period over the basin.

(b) *Crow Wing River*.—These observations cover the same period as those in the Mississippi, and the summary is given below.

Crow Wing River, area of basin 3,576 square miles.

Month.	Sum of discharges per second.	Average approximate daily discharge per second.	Total quantity of water passing.	Depth over basin.
	<i>Cubic feet.</i>	<i>Cubic feet.</i>	<i>Cubic feet.</i>	<i>Feet.</i>
November,* 1881.....	62,364.80	2,200	5,388,318,720	0.054
December, 1881.....	39,673.57	1,300	3,427,796,448	0.034
January, 1882.....	29,865.30	950	2,580,361,920	0.027
February, 1882.....	26,878.79	950	2,322,327,456	0.028
March, 1882.....	37,698.51	1,200	3,257,151,264	0.032
April, 1882.....	195,616.69	6,500	16,901,282,016	0.170
May, 1882.....	209,866.53	6,800	18,132,468,192	0.181
June, 1882.....	154,244.04	5,100	13,326,685,056	0.134
July, 1882.....	137,910.14	4,400	11,915,436,096	0.120
August 1882.....	96,345.46	3,100	8,324,247,744	0.083
September, 1882.....	66,863.38	2,200	5,776,996,032	0.058
October, † 1882.....	119,080.11	3,600	10,288,521,504	0.103
Total.....	1,176,407.32	38,300	101,641,592,448	1.019
Means.....	98,033.94	3,200	8,470,132,704	0.085

* 28 days.

† 23 days.

The depth over the basin in this case is found to be 1.019 feet, or a little over 12 inches. The area of the lakes within the basin of the Crow Wing is about 196 square miles. Subtracting this from the total area, 3,576 square miles, we have remaining 3,380 square miles, which, divided into the total quantity of water, gives a depth of 1.078 feet, or a little less than 13 inches.

In order to arrive at the precipitation the three stations at Moorehead, Leech Lake, and Crow Wing have been considered, with the following result:

	Inches.
Moorehead.....	31.71
Leech Lake.....	27.84
Crow Wing.....	33.02
Total.....	92.57
Mean.....	30.85

The depths of 1.019 feet and 1.078 feet compared with this mean precipitation, 2.570 feet, give the ratios 0.396 and 0.419, respectively; or, the quantity of water passing the Crow Wing River at its mouth, from November 3, 1881, to November 3, 1882, was about two-fifths of the precipitation over the basin.

(c) *Saint Croix River*.—Observations were carried on here from December 6, 1881, to December 6, 1882. The following is the summary :

Saint Croix River, area of basin 5,950 square miles.

Month.	Sum of discharges per second.	Average approximate daily discharge per second.	Total quantity of water passing.	Depth over basin.
	<i>Cubic feet.</i>	<i>Cubic feet.</i>	<i>Cubic feet.</i>	<i>Feet</i>
December,* 1881.....	90,027.60	3,500	7,778,384,640	0.047
January, 1882.....	85,489.89	2,700	7,396,283,296	0.044
February, 1882.....	95,175.10	3,400	8,223,128,640	0.050
March, 1882.....	128,885.59	4,100	10,962,914,976	0.066
April, 1882.....	428,980.84	16,100	41,729,544,576	0.251
May, 1882.....	487,787.00	15,700	42,144,796,800	0.254
June, 1882.....	291,943.50	9,700	25,223,918,400	0.152
July, 1882.....	306,660.82	9,900	26,495,494,848	0.160
August, 1882.....	180,910.53	5,200	13,902,669,792	0.084
September, 1882.....	113,489.60	3,800	9,805,501,440	0.059
October, 1882.....	194,921.55	6,300	16,841,221,920	0.102
November,† 1882.....	166,956.85	4,800	14,425,071,840	0.087
Totals.....	2,603,228.34	85,200	224,918,931,168	1.356
Means.....	216,935.69	7,100	18,743,244,264	0.113

* 26 days.

† 35 days.

The depth over the basin in this case, it will be seen, is 1.356 feet, or a little over 16 inches.

The area of the lakes within the basin is about 170 square miles, leaving 5,780 square miles of available area.

This area divided into the total quantity of water gives 1.395 feet, or a little less than 17 inches.

	Inches.
The precipitation at the observing station during the year was	28.06
At Duluth during the same period	37.11

Total	65.17
Mean	32.58

The depths, 1.356 and 1.395, compared with this mean precipitation, 2.715 feet, give the ratios 0.499 and 0.513, respectively; or the total quantity of water passing the Saint Croix River at a point 7 miles above Taylor's Falls from December 6, 1881, to December 6, 1882, was about one-half the precipitation during that period over the entire basin.

A comparison of the results obtained on these three rivers discloses quite a marked difference in the quantity of water passing, and when this is expressed in depth over the basin the Saint Croix is the greatest and the Mississippi smallest, with the Crow Wing taking an intermediate place.

The following comparative table shows the relations of the three streams to each other:

River.	Area of basin.	Area of lakes within basin.	Ratio of lake area to total.	Amount of precipitation.	Water passing, expressed in depth, over entire basin.	Water passing, expressed in depth, over basin, less area of lakes.	Ratio of water passing to precipitation—lat method.	Ratio of water passing to precipitation—2d method.
	<i>Sq. miles.</i>	<i>Sq. miles.</i>		<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>		
Mississippi	7,288	803	0.110	2,720	0.746	0.839	0.274	0.308
Crow Wing	3,576	196	0.054	2,570	1.019	1.078	0.396	0.419
Saint Croix	5,950	170	0.028	2,715	1.356	1.395	0.499	0.513

The causes of the great apparent loss on the Mississippi it is of course impossible to determine with certainty, but a careful examination of the topography of the basins

discloses very marked differences, especially between that of the Upper Mississippi and that tributary to the Saint Croix.

The basin of the Upper Mississippi has for one of its characteristic features immense areas of swamp, on a scale far exceeding anything in the Saint Croix Basin.

The general slope of the country is very small, the streams being sluggish, with infrequent rapids.

From Leech Lake to Crow Wing the fall of the river is about 147 feet and the distance by river not far from 300 miles, which would give an average slope of 0.49 per mile.

In the Saint Croix Basin, on the other hand, the slope of the country is sharp and the streams rapid. From Upper Lake Saint Croix (the lowest point of the divide from Lake Superior) to the gauging station the fall is about 263 feet and the distance about 150 miles, giving an average slope of 1.75 feet per mile. From the headwaters of the Kettle River (one of the principal tributaries of the Saint Croix) to the gauging station the fall is at least 500 feet and the distance about 150 miles, giving an average slope of 3.33 feet per mile.

The former is over three times and the latter over six times the slope of the Upper Mississippi. It would seem from this comparison that the conditions for detaining water in the basin and thus increasing the evaporation are much less favorable on the Saint Croix than on the Mississippi, and that the tendency of the rains to speedily seek the water courses would be much greater.

It will also be noted that while on the Upper Mississippi the area of the lakes is 503 square miles or 11 per cent. of the area of the basin, on the Saint Croix it is only 170 square miles or less than 3 per cent. of its area of basin.

What proportion of the water may seek a subterranean outlet through the lower strata is of course entirely conjectural with the slight geological data at hand.

Borings taken on the Saint Croix show the formation to be of a much harder character than on the Mississippi. Gravel, clay, and boulders are frequent. The basin is crossed in several places by upheaved dikes of trap or basalt similar to the Lake Superior formation, and these dikes, coming as they do from great depths, might possibly offer a barrier to subterranean drainage.

On the Upper Mississippi no rock in place is found except the slight outcrop at Pokegama Falls. All borings taken in that region show sand, underlain by an imperfect bed of clay, with sand below the clay to an indefinite depth. The presence of large wells flowing under great pressure on the east side of the Red River and the comparatively slight depth at which this flow is reached might possibly indicate some subterranean connection with the Mississippi Basin; but, as before remarked, with our present slight knowledge the whole subject must remain almost entirely a matter of conjecture.

The Crow Wing River lies between the Mississippi and the Saint Croix, in regard to the percentage of precipitation passing, and the same may be said of its slopes and the proportion of lake area included within its boundaries. The fall from its extreme northern sources, which lead close to Lake Itasca, cannot be less than 200 feet, and the distance about 160 miles, giving a slope of 1.25 feet per mile. The area of lakes is 196 square miles, or about 5 per cent. of the area of the basin.

It will thus be seen that while the great discrepancies in the percentages of precipitation issuing from these basins may not be explained by the differences of slopes and lake areas, there is at least a very remarkable correspondence between them, which is not unworthy of careful consideration.

Among the phenomena noted during the year was one of special interest observed during the early winter on the Crow Wing River.

This was the apparently close relation between the temperature and the mean velocity and discharge of the stream, the stand of the water being at the same time almost constant.

In the early winter it was found that each cold wave which increased the thickness of the ice about one-tenth of a foot at a time was accompanied at first by a great falling off of the discharge, to be followed by a partial recovery during the next few days, the same phenomenon recurring with great regularity at each cold wave.

The recovery of discharge being in each case only partial, the gradual tendency was downward until the apparent minimum was reached, when there was no appreciable change for several weeks. From December 12 to January 13 the fall of the water was just 0.03 foot, and in the interim the oscillation up or down was less than 0.1 foot. The discharge fell off from 1,355 cubic feet per second on the former date to 948 cubic feet per second on the latter, a decrease of 407 cubic feet per second, or about 30 per cent. Between these dates the Mississippi fell 1.1 foot, showing that the stage in the Crow Wing was not fictitious, as might have been the case had the Mississippi been rising. During the months of January and February the discharge of the Crow Wing was remarkably constant, fluctuating between 1,000 cubic feet per second and 900 cubic feet per second, without any apparent reference to the very slight variations in height of the water.

The following are the maximum and minimum discharges on the three streams:

Summary of maximum and minimum discharges.

River.	Maximum.		Minimum.	
	Quantity per second.	Date.	Quantity per second.	Date.
	<i>Cubic feet.</i>		<i>Cubic feet.</i>	
Mississippi.....	10,887	May 23.....	1,905	February 25.
Crow Wing.....	10,160	May 13.....	891	February 25.
Saint Croix.....	35,775	May 13.....	2,623	January 23.

During the winter a series of special observations was taken at Crow Wing, covering a period of forty days, to determine, if possible, the ratio of the mean velocity at any point to the mid-depth velocity. The velocities were taken a foot apart vertically in the deeper water, and one-half a foot apart in the shoaler water. Four points were selected for observations on the Mississippi and three on the Crow Wing.

The mean of these velocities, when plotted, corresponded very closely with the parabola.

A diagram showing four of these curves is submitted herewith. The work of determining the ratio of the mean velocity to the mid-depth velocity is not considered as complete enough to warrant any absolute statement, though it may be said in general terms that this ratio seems to be about 0.90, and possibly less.

There is also submitted a diagram on a reduced scale showing the method pursued in constructing velocity tables. The velocities are drawn as the horizontal co-ordinates; the seconds of time as the vertical co-ordinates. The time of one hundred revolutions of the meter being determined by actual observation at different velocities, these points are located on the diagram, and a curve, as nearly regular as possible, drawn through them. From this curve a table, covering all the seconds within the limits of observation, is readily constructed.

Second. METEOROLOGICAL.

(1st) *Precipitation.*—These observations were taken by means of the ordinary rain-gauge with a catch-basin of ten times the area of the cylinder in which the water is measured.

In winter the depth of fresh snow was measured on a board, the top of the rain-gauge used to cut out a cylinder of snow, which, after being melted, was measured, as in the case of rain.

All of these observations, both hydrological and meteorological, were taken well and faithfully by Mr. W. N. Mack, at Crow Wing, and Mr. O. B. Elmar, on the Saint Croix. I also wish to acknowledge the valuable services of Mr. H. Pederson, who since last May has assisted me in the long and tedious series of calculations incident to this work.

Very respectfully, your obedient servant,

JOHN B. PARKINSON,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

NOTE.—The diagrams are omitted.

REPORT OF A BOARD OF ENGINEER OFFICERS, RECONVENED BY SPECIAL ORDERS NO. 78, HEADQUARTERS CORPS OF ENGINEERS, UNITED STATES ARMY, AUGUST 11, 1882, TO CONSIDER THE CONSTRUCTION OF THE RESERVOIR DAM AT THE OUTLET OF LAKE WINNIBIGOSHISH.

SAINT PAUL, MINN., September 8, 1882.

The Board of Engineers constituted by Special Orders No. 90, Headquarters Corps of Engineers, 1880, reassembled at Saint Paul on the 7th of September, 1882, in pursuance of Special Orders No. 78, Headquarters Corps of Engineers, 1882, all the members present, Maj. Alexander Mackenzie having been detailed as a member of the Board in lieu of Maj. Garret J. Lydecker.

The Board reconsidered the report made by them in August, 1880

(Annual Report of the Chief of Engineers for 1881, Part II, page 1763), and has the honor to submit the following additional report:

The Board in 1880 was instructed to consider and report on a project for a dam at the outlet of Lake Winnibigoshish, on the Mississippi River, proposed by Maj. C. J. Allen. Major Allen's project consisted of an earthen embankment, with sluices through it to control the discharge from the reservoir.

It was calculated that these sluices would provide for the entire discharge of the river at all times. The Board, after careful consideration, concurred in Major Allen's project, with but two modifications:

First. That the cross-section of the embankment could be safely reduced; and

Second. That the portion of the dam containing the sluices should be of crib-work on a pile foundation.

In forwarding the drawings to accompany the report of the Board, the senior officer called attention to the height of the embankment, and recommended that it be raised 2 feet.

In his letter to the Chief of Engineers, dated March 22, 1882, Major Allen, after further investigation and study, recommended that the cross-sections and height of the embankment and the thickness of the crib-work be increased. He also recommended a reduction in the size of the sluices, for the reasons stated in his letter, a copy of which is appended to this report.

Major Allen's recommendations were approved by the Chief of Engineers, and the work is now being carried on in accordance therewith.

A cross section* of the embankment as now being constructed, with some changes suggested by Major Allen, is submitted herewith.

The main body of the embankment is of sand; its top is 6 feet above high water in the reservoir. The width on top is 10 feet. Both slopes are 1 vertical to 2 base. In the center is a diaphragm of timber 6 inches thick and a puddled wall. The slopes and top are to be covered by a layer of clay and gravel from 1 to 2 feet thick; the down-stream slope to be sodded; the up-stream slope and top surface to be paved with stone, and the foot of the slopes to be protected by sheet-piling and stone.

The Board is of the opinion that this embankment has all necessary stability; that it is protected as thoroughly as necessary from percolation and from the destructive action of waves, rains, and other sources of injury, and that, as far as can now be foreseen, it meets all requirements.

In reference to the sluices, the Board does not think it necessary to increase the thickness of the walls between them. Any additional strength required may be given by means of angle-irons. The Board concurs in Major Allen's recommendation that the width of the sluices be reduced from 5 to 4 feet, as the gates can be more easily operated, but would recommend that the total area of the openings be about the same as in the original project.

Respectfully submitted.

D. C. HOUSTON,
Lieutenant-Colonel Engineers, Brevet Colonel.

HENRY M. ROBERT,
Major Engineers.

CHAS. J. ALLEN,
Captain of Engineers and Brevet Major, U. S. A.

To Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

* See preceding report of Major Allen.

LETTER OF CAPTAIN CHARLES J. ALLEN, CORPS OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
Saint Paul, Minn., March 22, 1882.

GENERAL: The timber for the Winnibigoshish Dam is about all on the ground. The saw-mill, pile-driver, and other machinery will probably be in readiness by the 3d or 4th of next month.

The general plan of embankment and timber work for this dam was stated in the report of a Board of Engineer Officers, convened by special order of July 24, 1880. The drawings illustrative of the details were forwarded by the president of the Board on the 21st of December.

Since that plan was forwarded fuller information as to the locality and kind of material has been gathered, and, from knowledge gained by personal examination of the ground during the past winter, I would respectfully urge some modifications of the details of that plan. They are:

First. To raise the embankment to a height of 6 feet above the surface of high water in the reservoir, and to make the top width of embankment 10 feet, and to make the down-stream slope 1 on 2 instead of 2 on 3.

The embankment must be constructed largely of light sand containing little or no admixture of organic or loamy matter; selected material for the core of the embankment is not so abundant as was at first thought.

The reservoir is to have a capacity of some 45,000,000,000 cubic feet, and, although it will seldom be entirely filled, should a break in the embankment occur, the sudden liberation of such a volume of water would be attended with disaster.

The lake has a fetch from west to east of about 10 miles, and the waves at the east and sometimes rise to a height of 4 to 5 feet. Waves overtopping an embankment, even when it is paved, are apt to produce injurious action.

The profile of embankment, as per report of August 5, 1880, is shown on Figure 1 in full black lines. The addition suggested in Colonel Houston's letter of December 21, 1880, to the Chief of Engineers, is indicated on the same figure in dotted black lines; and the increase that I would suggest is shown on the same figure in broken lines. The increase in quantity of earth embankment and stone, as by the black dotted lines, is about:

	Cubic yards.
Earth.....	1,000
Stone.....	140

The further increase, following the broken lines, is about:

	Cubic yards.
Earth.....	12,000
Stone.....	700

The greater part of the earth being lighter than at first supposed, and more easily handled, its cost in embankment will be reduced over that originally figured. It is thought that it can be put in for 20 cents per cubic yard, selected material excepted.

With my letter of April 22 last was a tracing showing cross-sections of several existing reservoir embankments.

I give below a list, from my note-book, of cross-sections of reservoir dams taken above a line 14 feet below high-water mark. The figures are believed to be nearly if not quite correct. They are:

	area.....	Square feet.
Rotten Park Dam.....	area.....	1,301
Baun Dam.....	area.....	510
Birmingham and Warwick Dam.....	area.....	782
Chestnut Hill Dam.....	area.....	1,200
Druid Lake Dam.....	area.....	2,552

	area	Square feet.
South Lake Dam.....	area	1,092
Croton Dam.....	area	2,534
North Branch Dam.....	area	938
Woodhull Dam.....	area	841
Doe Park Dam.....	area	1,234
Grimwith Dam.....	area	1,130
Stubden Dam.....	area	1,130
Barden Dam.....	area	1,092
Silsden Dam.....	area	1,234
Bombay Dam.....	area	1,430
Utley Dam.....	area	1,300
Invercannie Dam.....	area	816
De Ruyter Dam.....	area	1,686

The areas of cross-section proposed for the embankment of the Winnibigoshish Reservoir, above the same line, viz, a line 14 feet below high water, are (Figure 1):

	Square feet.
As per report of August 5, 1880.....	688
As per dotted black lines.....	711
As per broken lines.....	1,000

Second. To reduce the clear widths of the sluices from 5 feet to 4 feet, and to slightly increase the thickness of the timber trunk containing the group of sluices. Figures 2 and 3 below show, in full black lines, cross profile of crib-work through sluice, and plan of sluices, as given in the report of August 5, 1880. The modifications suggested are shown in broken lines.

For the same reason as in asking an increase in cross-section of embankment, I would ask to be allowed to increase the thickness of the top portion of the timber work from 14 feet to 16 feet, and of the offset or partial apron below it from 10 feet to 12 feet. The additional quantity of material involved would be about:

Of timber, feet, B. M.....	29,000
Of stone, cubic yards.....	300

As we get the timber out and saw it ourselves, a small increase in the bill of timber amounts to little or nothing. An increase in cross-section would add to the stability of the structure as against waves, and particularly against the vibratory motion that the rush of water, under a head of 14 feet through the sluices, would engender.

The original plan provides for twenty sluices each 5 feet by 5 feet in the clear. It is recommended to reduce these to 5 feet by 4 feet (the latter the horizontal measurement) in order to save material (oak and iron) to some extent in the construction of the gates, but mainly with a view to reducing the labor and time in raising the gates. An additional advantage would be gained, in reducing the width of sluice, by adding the foot thus taken off to the thickness of the sluice wall, enabling the latter to better sustain vibration from the rush of water.

Twenty sluices, each 5 feet by 4 feet in the clear, will afford a waterway of 400 square feet in cross-section. Under a head of 14 feet, the discharge of water would be 9,600 cubic feet per second, three times as much as it is proposed to draw, at any time, from the reservoir. Under a head of 1 foot, the discharge would be about 2,500 cubic feet per second. By the time the surface of water in the reservoir reaches the latter stage the river below will have about closed for the season.

It is believed that the total increase in cost, if these modifications are made, will not exceed \$3,500.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

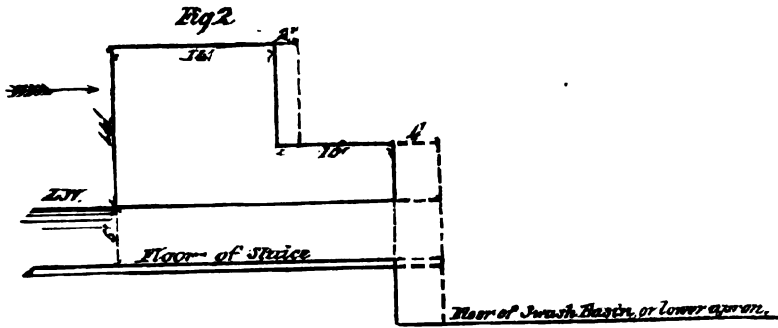
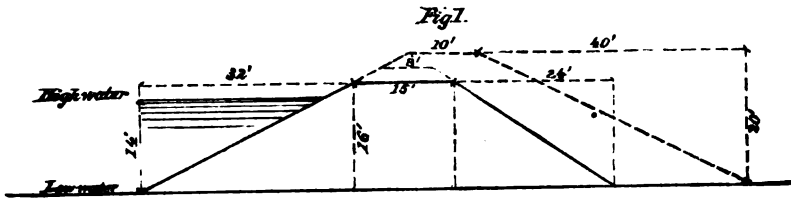
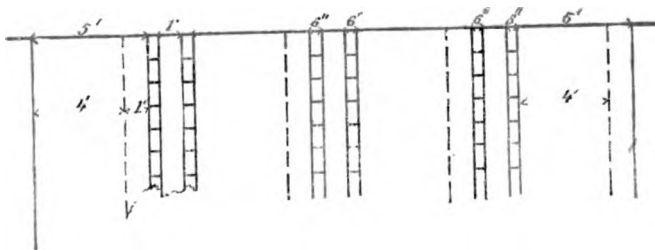


FIG. 2.
Plan of Stairs.



X II.

SURVEYS FOR RESERVOIRS AT THE SOURCES OF THE MISSISSIPPI, SAINT CROIX, CHIPPEWA, AND WISCONSIN RIVERS.

If the reservoir work now begun in Minnesota at the headwaters of the Mississippi River is to extend to the Saint Croix, Chippewa, and Wisconsin rivers, it will be necessary, in order to meet questions constantly arising, as well as to be enabled to make closer estimates of cost of dams, &c., to continue hydrological observations, to continue borings at proposed dam-sites, to recontour some of the sites, and to work up of maps, drawings, and estimates. The estimated cost of such examinations for one year is \$49,000. There having been no appropriation for such work during the past fiscal year nothing was done under this head.

Money statement.

Amount that can be profitably expended in fiscal year ending June 30,	
1885.....	\$49,000 00

APPENDIX Y.

IMPROVEMENT OF TENNESSEE AND CUMBERLAND RIVERS, AND OF RIVERS IN EASTERN TENNESSEE, GEORGIA, AND KENTUCKY.

**REPORT OF MAJOR WILLIAM R. KING, CORPS OF ENGINEERS, OFFICER
IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER
DOCUMENTS RELATING TO THE WORKS.**

IMPROVEMENTS.

- | | |
|--------------------------------------|--|
| 1. Tennessee River. | 10. Oostenaula and Coosawattee rivers,
Georgia. |
| 2. Cumberland River. | 11. Ocmulgee river, Georgia. |
| 3. Hiwassee River. | 12. Oconee River, Georgia. |
| 4. French Broad River, Tennessee. | 13. Red River, Tennessee. |
| 5. Clinch River, Tennessee. | 14. Little Tennessee River, Tennessee. |
| 6. Duck River, Tennessee. | 15. South Fork Cumberland River, Ken-
tucky. |
| 7. Obey's River, Tennessee. | |
| 8. Caney Fork River, Tennessee. | |
| 9. Coosa River, Georgia and Alabama. | |

UNITED STATES ENGINEER OFFICE,
Chattanooga, Tenn., August 6, 1883.

GENERAL: I have the honor to submit herewith annual reports on
the works under my charge for the fiscal year ending June 30, 1883.

Very respectfully, your obedient servant,

W. R. KING,
Major of Engineers.

CHIEF OF ENGINEERS, U. S. A.

Y I.

IMPROVEMENT OF TENNESSEE RIVER.

I.—ABOVE CHATTANOOGA.

From Chattanooga to Knoxville, a distance of 189 miles, the Tennessee River is navigable during the greater part of the year, and the object of the present plan of improvement was to remove obstructions and deepen the channel at shoal places, so as to secure a depth of at least 3 feet at low water.

Examinations made in 1830 and in 1872 show that by the removal of twenty-nine obstructions a channel could be secured that would answer all the purposes of navigation.

The obstructions consist chiefly of reefs of rock, with occasional shoals of sand and gravel, and the method of improvement consists in blasting a channel through the reefs, and building stone wing-dams to contract

the channel and cause it to scour deeper or become deeper by the additional volume of water thrown into it. Nearly all of these obstructions have been more or less improved; many of them entirely removed and others reduced to secondary importance as obstructions.

The regimen of this river is practically permanent, but little change having occurred in the past fifty years, and as the rock excavations, stone, dams, &c., are but little affected by the elements, there being no ice to contend with, the improvement once made is practically permanent. Where any damage has occurred to the dams it has generally been traced to causes that can be avoided in future, or to the wanton acts of parties who made gaps in some of the longer dams to shorten the distance over which they were moving boats.

The annual appropriations for several years past have been so small that but little work could be done, and the cost of what was done has, for the same reason, been greater than it should have been.

Active operations were begun at Little River Shoals, a few miles below Knoxville, soon after the appropriation of August 2, 1882, became available, and were continued, with a small force, at these shoals and Williams' Island Shoals until the funds were exhausted in January, 1883.

The work at Little River Shoals was thought to have been completed in 1881, but it was discovered that the scouring of the channel was not progressing as it was hoped it would, and considerable additional work was done at this place before proceeding to Williams' Island Shoals.

The following are the quantities of work done during the working season:

	Cubic yards.
Rock quarried for dams	798
Rock placed in dams	466
Rock placed in revetment wall	273
Old dams (State) removed, 120.	
Earth stripped from quarry	549

The work was continued under the local charge of Assistant Engineer J. S. Crary, and was carried on by hired labor.

There are twelve steamboats of from 50 to 225 tons capacity on this river, and large quantities of coal, iron ore, grain, and miscellaneous freight are transported by them, in addition to which a very large and increasing lumber trade is established on the upper Tennessee and its tributaries.

It is hoped that a sufficient appropriation will be made to extend the improvement to Knoxville, and to still further improve some of the obstructions already partially removed.

The estimated cost of improving the Upper Tennessee River, as made in

1872 and 1874, and modified in 1877, was.....	\$225,000 00
Amount appropriated	215,500 00
Amount expended	215,212 95

Money statement.

July 1, 1882, amount available	\$37 70
Amount appropriated by act passed August 2, 1882	7,000 00
	7,037 70
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$6,690 98
July 1, 1883, outstanding liabilities	59 67
	6,750 65
July 1, 1883, amount available	287 05
Amount (estimated) required for completion of existing project	9,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	9,500 00

II.—BELOW CHATTANOOGA.

At the beginning of the fiscal year there were no funds for this work, but as soon as the appropriation of August 2, was made, active operations were renewed and pushed vigorously until about the 1st of April, when the funds were again so nearly exhausted that it became necessary to reduce the force at all points, and employ the small remaining force in closing up such parts of the work as could be suspended with least disadvantage, and continuing on a reduced scale those parts most desirable to be forwarded with a view to the ultimate completion of the work.

As heretofore the principal and almost the entire work undertaken has been at the Muscle Shoals obstruction, which forms the great barrier to navigation in this river. All other obstructions are of minor importance and their improvement can only be fully utilized when the Muscle Shoals Canal is navigable.

The following extracts from my last annual report will serve to recall the description and historical facts relative to this improvement.

This portion of the Tennessee River, from Chattanooga to Paducah, 453 miles in length, is now navigable excepting at the Muscle Shoals, where about 23 miles of obstructions are in process of removal. The completion of this work will connect 425 miles of navigable water in the Tennessee above the Muscle Shoals, besides hundreds of miles in its navigable tributaries, with 255 miles of river below Muscle Shoals, and thence with the entire Mississippi system.

As early as 1824 Mr. Calhoun, then Secretary of War, mentioned the canal around Muscle Shoals as *third* in rank among the proposed improvements of national importance. In 1828 surveys were made with a view to building a canal around the Muscle Shoals, and Congress donated 400,000 acres of land to the State of Alabama for building it, but the canal was never properly completed and went into disuse soon after it was opened.

In 1867 an examination of the river from Chattanooga to Paducah was made, and in 1872 an instrumental survey of the Muscle Shoals was completed, upon which the present project for the improvement was based; modified, however, by a resurvey of the Elk River Division in 1877.

The existing project consists in enlarging and rebuilding the old canal, 14½ miles long around Big Muscle Shoals; extending the improvement around the Elk River Shoals, about 8 miles, and Little Muscle Shoals 5 miles long; and in removing a number of minor obstructions in the navigable portions of the river, both above and below these great obstructions. For this purpose the estimates were \$4,133,000, and with annual appropriations of even one-half of the amounts of the estimates the river would now be navigable, and the commerce of North Alabama and East Tennessee would be joined to that of the Mississippi Valley.

The appropriations have, however, been less than one-third of what could have been profitably expended, and the period of completion has consequently been delayed for several years.

The entire chain of obstructions, from deep water at Florence to deep water near Brown's Ferry, is 36 miles long, of which 8 miles require no improvement, and of the balance 16 miles are overcome by canal alongside the river, and 12 miles have been improved by building wing-dams and heavy retaining dams of stone, and by blasting a channel from the solid rock in the river bed.

This last operation which is practically completed, was done by means of temporary dams, which were so located as to divert the river from the channel to be worked in, and by coffer-dams which inclosed successive portions of the river bed, so that they could be pumped out, and the rock thus exposed was blasted out with nearly the same facility as if it had been on dry land. In this manner about 2½ miles of channel were blasted out, involving the removal of over 100,000 cubic yards of rock, the improved channel thus formed being smooth and uniform in section, 110 to 120 feet wide and 3 feet deep at extreme low water. This

work required over 4,500 linear feet of temporary dam and 14,000 feet of coffer dam.

The permanent stone dams completed aggregate about 3 miles in length, and contain over 80,000 cubic yards of stone. With some extensions and additions to these which can be made at almost any stage of the river, but which will not be absolutely needed excepting during the low-water season, the 12 miles of open channel improvement will be completed.

The 16 miles of canal is also well advanced towards completion, and was never in better condition for rapid and economical work than at present if funds were available.

The canal consists of $14\frac{1}{2}$ miles of old canal, which is being rebuilt, and $1\frac{1}{2}$ miles of new canal on the Elk River division. The latter requires two locks, one having a 12-foot lift and the other from 5 to 10 feet according to stage of water in the river. One of the foundation pits has been excavated and about one-seventh of the canal trunk excavation has been completed. The stone for one lock and about one-half of that for the other has been quarried and cut, a large portion of which had to be procured on the Memphis and Charleston Railroad, about 6 miles west of Decatur. Twenty-five acres of heavy timber have been cleared from the land upon which the canal is located, and several acres of drift wood, including snags, saw-logs, &c., have been removed from that part of the river to be used as a boating channel.

On the old canal work is still further advanced. The entire length of the canal has been cleared of the heavy timber which had grown up since the old canal was abandoned, and about five-sixths of the canal trunk has been enlarged, deepened, and straightened, these operations requiring the removal of 634,000 cubic yards of earth and 88,000 cubic yards of solid rock. The upper end of the canal has been extended through solid rock out to the deep water in the river by means of coffer dams and a large embankment of excavated rock has been extended some 800 feet into the river to form a safe entrance to the canal.

The seventeen old locks, which were only 32 feet wide and 118 feet long, have been replaced by nine new locks, 60 feet wide and 300 feet between gates. These locks have a greater aggregate lift than the original locks—namely, 84 feet normal lift and an extreme lift of 94 feet. The entire masonry of these nine locks is completed, and they are ready for the gates.

The piers and abutments of Shoal Creek Aqueduct, twenty-seven in number, are also completed. They are each 75 feet long, and average 11 feet in height.

All the masonry is founded upon solid rock, and in most cases the surface of the rock had to be blasted down to the proper level to receive the first course of masonry.

At Bluewater Creek a permanent bridge has been built, having seven piers and two abutments. All the masonry has cut beds and joints, and was laid in hydraulic cement. These piers are grooved at the sides to receive the sections of a permanent dam to be thrown across this creek when the canal is ready for filling. The bridge carries a railroad track, which is used for construction trains, and is eventually to be used in operating the canal.

At Second Creek, abutments have been built of similar description and for the same purpose, and at Douglass Branch a stone waste weir 60 feet long, and carrying also a railroad bridge, has been completed.

The construction railroad now extends the entire length of the canal

and is in fair working order, with enough rails on hand for building the necessary track for transporting the stone and other material for the Elk River locks.

The following are the details of the work done on the different divisions during the year:

1. ELK RIVER DIVISION.

As soon as funds were available for resuming active operations (August 2) a large force of men with two steam-drills were set at work blasting out the channel opposite Gilchrist's Island. For this purpose a temporary dam 600 feet long had been thrown across the head of the channel, and coffer-dams were built during the progress of the work inclosing successive portions of the channel, which were unwatered by means of steam-pumps.

By the end of November, 18,689 cubic yards of rock were blasted out and removed from the channel, which practically completed all the open channel excavation, not only on this division but on the entire Muscle Shoals improvement.

The channel excavated in this case was 2,800 feet long, 110 feet wide, and 3 feet below extreme low water, the depth of rock removed varying from a few inches to 3 feet.

At the Trinity Quarry the quarrying and cutting of stone for Locks A and B was continued until April 14, when the stonecutters and quarrymen were dismissed for lack of funds.

The Wardwell steam channeling machine, although working about as well as was expected, was not found economical on account of the great number of dry seams found in the quarry.

The Gilchrist Quarry was also worked as long as the condition of the appropriation would justify.

The quantities quarried and cut during the year were—

	Cubic yards.
Cut stone.....	606
Rock face.....	346
Rubble scabbled.....	281
Dimension stone quarried.....	955
Backing stone quarried.....	1,155

These quantities with those already reported will be sufficient to build one of the locks and about one-half of the other.

A side-track was laid at Trinity about 2,000 feet long for removing the stone, and one at Decatur, with the necessary derricks for transferring the stone from the cars to boats. It will be remembered that this is the only case in which we were unable to find suitable building stone in the vicinity of the locks.

On the south bank of the canal an embankment was raised sufficiently by excavation from the canal trunk to make a suitable road-bed for the construction track between the locks, and the necessary rails were procured for the purpose.

Considerable work was done in repairing and strengthening the permanent retaining dam above Lock A, and in removing the temporary spur-dam opposite Milton's Bluff.

This division has remained in local charge of Assistant Engineer J. E. Willard until May 1, and of Assistant Engineer W. A. Toms since that date. The average force of men employed has been one hundred and fifteen.

2. BLUE WATER AND SHOAL CREEK DIVISIONS.

These divisions embrace the old Muscle Shoals Canal, and have been in charge of Assistant Engineers H. J. Gielow and Robert Hooke, respectively, and good progress has been made until the work was closed for lack of funds. The average force of men employed on these divisions was two hundred and thirty.

The following are the principal items of work done during the fiscal year:

	Cubic yards.
Ax-face stone cut	1,018
Rock-face stone cut	750
Backing scabbled	864
Ax-face masonry laid	2,733
Rock-face masonry laid	1,496
Rubble masonry laid	6,495
Dimension stone quarried	1,797
Backing quarried	3,520
Solid rock excavation	9,007
Loose rock excavation	2,110
Earth excavation	24,942
Earth embankment	25,733
Rock put in dam	7,349
Slope wall built	710
Débris removed from locks	1,710

There was also the usual amount of contingent miscellaneous work done; repairs to locomotives, cars, and other machinery, buildings, &c., and in storing the property at the close of the season's work.

A large and convenient building was built for an engine-house and repair shop, by combining the materials from a number of old buildings no longer needed for the work, which makes an inexpensive structure, and at the same time one sufficiently durable to last as long as it will be required.

The iron beams, plates, and heavy castings were procured for all the gates of one lock, and it is hoped that the funds on hand will be sufficient to put the gates together and fit them in their places.

3. BELOW FLORENCE.

Early in September a small snagging party under Assistant Engineer James H. Mayhew was started from near Johnsonville, Tenn., and after working down the river to Paducah they were towed back to Waterloo, removing 372 snags and 296 overhanging trees on the way, some of the former being exceptionally large and troublesome to navigation. A small mound of conglomerate at the head of Sandy Island was reduced about 1 foot, when cold weather and high water put a stop to further operations about the 1st of December. In addition to the work actually done he was instructed to keep careful notes of such obstructions as could not be removed by his party, and his detailed report will be valuable in future operations on this part of the river.

During the past few months, in closing up the work, it was found advantageous to clear away the *débris* from a quarry below Florence, where dimension stone had been procured, and about 1,327 cubic yards of rough stone were boated to the nearest point where they could be used to advantage, namely, Tuscumbia Bar, and placed in riprap dams to deepen the channel.

Five packets, with an aggregate capacity of 3,000 tons, make regular weekly trips on the Lower Tennessee, and five tow-boats with barges, having a combined capacity of 10,000 tons, make irregular trips. It is

understood that a new company has been chartered recently under the title of the Florence, Evansville and Nashville Steam Packet Company, to establish a regular line of steamers on the Tennessee and Cumberland rivers, between Evansville, Ind., Florence, Ala., and Nashville, Tenn.

The funds available and the appropriation herein estimated for should be expended in continuing operations at Muscle Shoals and improving navigation at minor obstructions on the balance of the river between Chattanooga and Paducah.

In connection with the foregoing report, I have the honor to submit the following drawings and descriptions of sundry appliances that have been made or used on this work, some of which, it is hoped, may possess sufficient novelty and merit to render them useful on other works of similar character.

The estimates of cost of improving Tennessee River below Chattanooga were.....	\$4,133,000
Amount appropriated	2,345,500
Amount expended	2,321,850

Money statement.

July 1, 1882, amount available.....	\$8,852 16
Amount appropriated by act passed August 2, 1882	250,000 00
	<hr/> 258,852 16
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$225,198 07
July 1, 1883, outstanding liabilities.....	10,004 09
	<hr/> 235,202 16
July 1, 1883, amount available	<hr/> 23,650 00
Amount (estimated) required for completion of existing project.....	1,787,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	700,000 00

DESCRIPTION OF APPLIANCES USED ON THIS WORK.

I.—DERRICK WINCH.

Sheet No. I represents a light iron winch, designed more especially for use where there is but little lift and considerable lowering. In such cases the fall is hauled in rapidly by hand until all the slack is taken up, and then three turns are taken around the grooved cylinders (as a cable would be wound upon an ordinary capstan) and carried under the small pulley (a), after which the heavy lifting is done by the cranks.

The power is multiplied by the endless screws, so that each man at the cranks would be equal to fifty-four men on a direct pull, less the amount lost by friction. Lowering may be done by one man, simply by slacking off the free end of the fall.

Although the endless screw generally involves more friction than gearing, it will be noticed that in this arrangement one screw opposes the other, so that there is practically no friction anywhere else about the crank shaft, and, when properly greased, the screws themselves work quite freely.

The entire affair is in one compact mass, and simply requires two bolts to attach it to any ordinary derrick or crane. Its weight is only about 300 pounds.

Its advantages are compactness, great power when required, but rapid motion to the fall when not lifting a load, and avoidance of the rapid wearing of the rope which takes place on the ordinary derrick-drum where the rope winds upon itself.

II.—DERRICK GRAPPLE.

This machine will be readily understood from the drawing (sheet II), where it is shown in front and side view. It operates something like the clam-shell dredge bucket, opens when lowered by the rope and closes when raised by the chain, but it is very much lighter and simpler than most appliances of the kind.

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The "grip" is about double the weight lifted and appears to be sufficient for handling ordinary rough stone. The one represented in the drawing weighs only 335 pounds, but it will easily handle 3 cubic yards of rock or about forty times its own weight, while a small brass model lifts 1,500 times its weight.

III.—PORTABLE DRILL (FOR BUILDING IRON LOCK GATES).

In building iron lock gates like those represented on sheets IV and V, it is desirable to have a light drilling machine that can be set at any point in a space of 19 by 34 feet, and for this purpose the machine represented on sheet III was devised. It is driven by a small round belt connecting with the engine, and the latter, a small up-right engine with its boiler, is placed upon a truck, which in turn rests upon a traveler and can easily be moved in any direction so as to keep the belt tight.

The entire machine weighs only 41 pounds, and slides upon the lower flange of an I girder, so as to drill an entire row of holes without moving anything but the little machine itself. The girder can also be moved sideways, so as to bring the drill over any desired part of the work.

IV.—PROPOSED IRON LOCK GATE, WITH TRUSSED GIRDERS.

Sheet No. IV shows a form of iron lock gate which was devised with a view to securing the necessary strength and rigidity in all directions with the simplest combination of parts. The heel post is of cast iron and the miter post of wrought iron and wood. The girders are made of two 9-inch I girders, one straight and the other bent in two places so as to give a depth of 33 inches in the middle, the ends being bolted together after cutting away one flange from each beam, so as to bring the two webs in close contact. Two 12-inch I girders are placed vertically at one-third the length of the gate from each end, and are firmly clamped to the 9-inch girders, and the ends of the latter are secured to the heel and miter posts by cast-iron brackets, which are bolted between each pair of trussed girders. The plating is put on vertically, the distance between girders being regulated so as to give the necessary support to the plates as well as to equalize the strains upon the girders themselves. The bottom and lower side of the gate are also plated, so as to give buoyancy and relieve the strain upon the strap at the top of the heel post.

Although this form of gate is thought to possess many advantages over those made up of a multiplicity of small pieces of angle iron, plates, girders, and rivets, it was not considered as advantageous, all things considered, as that shown on sheet V, which is in many respects similar in construction.

V.—PROPOSED IRON LOCK GATE, WITH SOLID GIRDERS.

The general structure of this gate is similar to that just described, but differs from it in the substitution of solid 15-inch I girders for the compound girders, and of four 9-inch diagonal girders for the two 12-inch vertical girders. There is no plating on the lower side, as the displacement gained would be too small to compensate for the extra weight and expense.

The plating is put on without bending, and for this purpose alternate plates are "lined up" the thickness of the plates upon which they rest.

It will be noticed that the diagonal girders riveted to the back of the gate are so placed as to give resistance against torsion, as well as equalize the strain among the girders and transmit a portion of the same to the miter sill.

The heel posts have been cast without difficulty in a single piece, the thickness of metal being $1\frac{1}{2}$ inch.

The hollow gudgeon at the bottom is to be turned and fitted into the heel post, so that the latter will not require to be put in a lathe.

Only about 1,200 rivets will be required for a leaf of this gate, or about one-sixth of the number required for the same size of gate built of plates and angle irons in the usual way.

This gate is somewhat lighter and simpler in construction than that just described, and special care has been taken to introduce no difficult form of casting, and only those forms of rolled iron that are readily procured at rolling-mills.

VI.—WICKETS DESIGNED FOR THE MUSCLE SHOALS CANAL.

In all the locks at Muscle Shoals the water is passed around the gates through side culverts, and for the purpose of closing these culverts the wicket shown on sheet VI was devised.

It is well known that the balanced wicket is the simplest and easiest managed one, but its liability to leakage, especially after the bearings become worn, is thought by many to outweigh its advantages.

The object in view in designing this wicket has been to overcome this difficulty and to provide for taking out, repairing, and replacing all parts of the structure without pumping out the water from the culvert.

A vertical opening is left in the masonry 12 inches wider than the culvert and extending to the top of the coping. In this opening is placed a light frame, which rests against the stone and is grooved on the inside of the stiles to admit a sliding panel (a), which closes the entire space above the wickets, and has openings in the top and bottom transoms, through which the axes of the wickets pass. A small set-screw at each side (not shown in the drawing) raises or lowers this panel so as to keep a tight joint at the top and bottom of the wickets and allow for any wearing that may take place; and by similar means the wear at the side is provided for.

In adjusting this latter, one wicket is first closed firmly against the stile, the other wicket is then closed against the edge of the first, and the joint between the second wicket and stile is then closed by an adjustable cleat (not shown), which can be operated from the top of the frame.

It will be noticed that the upper panel, wickets, and outer frame can be removed in succession and replaced without unwatering the culvert.

VII.—BRIDGE AT BLUE WATER CREEK, MUSCLE SHOALS CANAL.

This bridge was designed to carry a track for construction trains and for towing purposes, and consists of eight spans, each 48 feet long, and so constructed at the piers as to form a continuous bridge.

The piers are to act as buttresses for a permanent dam, and in order to give sufficient room over the crest of this dam the truss-rods were raised by placing bolsters upon the chords at the piers, which gives the bridge a semi-suspension character, and necessitates the anchorage shown behind the abutment.

Other details will be readily understood from the drawing.

VIII.—SWITCHING LOCOMOTIVE (IMPROVED).

The drawing shows the construction of a small, inexpensive locomotive, which was built on short notice for the Government works at Muscle Shoals.

The frame is similar to an ordinary car-truck, but somewhat longer and lower, the jaws being shortened and the springs reduced to 2 inches of rubber. The wheels, axles, jaws, boxes, &c., are those in common use, and in fact most of these parts had been in use on ordinary trucks. The power is applied to one of the axles through a 30-inch gear-wheel, which engages a similar wheel attached to the small hoisting-engine which furnishes the power.

Almost any compact form of engine could have been used, but this one is a double cylinder yoke engine, with cylinders 6 inches in diameter and 8-inch stroke. It has a reversible-link motion, and is so geared that the engine makes nearly five revolutions to one of the drive-wheels, an arrangement designed to give plenty of power but a moderate speed.

The boiler is of the plain upright tubular pattern, 32 inches in diameter and 60 inches high, and is so placed that nearly its entire weight, as well as that of the engine and water tank, comes over the drive-wheels.

The entire cost of the truck and fitting up the engine and boiler, which were already on hand, was \$365.

The engine can easily be managed by one man, and hauls a car weighing 20,000 pounds up a grade of 200 feet to the mile, the arrangement being such that the loaded cars all come down grade.

IX.—EXPERIMENTAL TOW-BOAT, TO RUN UP-STREAM BY ACTION OF THE CURRENT.

Sheet IX represents one of a number of models which were made several years ago to test the possibility of towing boats up-stream by the action of the current.

It is evident that if an ordinary steamboat—either a propeller or with side or stern wheels—be anchored in a strong current, the wheel would be turned by the water in the same manner as an ordinary water-wheel, and a certain mechanical power would be developed. Now, if this power, whether great or small, be applied by means of suitable gearing or other multiplying device to a capstan, it may be made to haul in the cable and thus move the boat up-stream.

The model represented was simply designed to show these principles experimentally, and consisted simply of two small tin boats, with a paddle wheel between them and a drum at each end of the shaft, upon which the cables were wound by the revolutions of the wheel.

Several other forms were tried, but none were found that gave promise of sufficient power to be practically useful. There is so much loss from friction and current resistance that the results would not encourage the trial of a large boat on this principle.

X.—TESTS OF WOODEN BEAMS.

Sheet X shows the results of testing on a small scale twelve forms of wooden beam, made with a view to ascertain the effects of bevels, notches, and mortises, on the strength of the beams.

The beams were made of Tennessee poplar, which is similar to northern white-wood, and the timber was selected so as to secure a uniform quality.

The forms and dimensions of the beams will be readily understood from the drawings, and the breaking weight as given in each case is the average of two tests which generally differ from each other by less than 5 per cent.

One of the most remarkable facts shown is that a beam may be greatly *strengthened by cutting away certain portions* so as to make the strength at each point proportional, to the strain upon it. Thus beams Nos. 3, 5 and 8, when cut away to the form of 4, 6 and 7, become from 27 to more than 100 per cent. stronger, according to the depth of the shoulder cut away.

Several experiments were also made with different kinds of timber growing in this vicinity with a view to their adaptability for lock gates, but the results are not deemed of special interest in this connection.

XI.—FIGURE 1—STONE BARGE WITH SLOPING DECK.

This form of barge was intended to facilitate unloading rough stone, in building dams, without the use of derricks. The only novelty consisted in placing a sloping skeleton deck above the ordinary deck, the angle being such that the stone would not slide without some slight assistance. The rafters were shod with fish-plate iron so that two men with crowbars could readily slide almost any size of stone down, one at a time, quicker than they could be unloaded with a derrick. It was found in practice, however, that as the center of gravity of the load was very high and the boat rather narrow, great care was necessary to prevent accidents. Careless men would sometimes leave the stone unchocked, so that the wind or a strong current would cause the barge to careen and dump the load prematurely. I believe the plan is perfectly feasible, and that with a slight reduction in the slope of the deck and proper care in loading and securing the stone it would be a very economical plan for unloading. In taking the stone from the quarry a derrick is necessary, and of course the stone can be placed upon this kind of barge as readily as upon one of the ordinary kind.

XI.—FIGURE 2—TEMPORARY DAM.

This form of dam was designed for use in tolerably shallow water, and where the river bed was so smooth and firm as not to cause much trouble from scouring. It differs from the ordinary tripod dam in several respects, and has the advantage that the frames or "grasshoppers," as they were called by the workmen, can all be put in and the bottom plank can be put down and puddled before the water level is raised appreciably; after which there is no trouble in sliding down the other plank in succession until the water is raised to the desired level. When the planks are placed vertically, as in the ordinary tripod dam, the water is raised as the work proceeds, and finally a strong current is produced through the opening that renders it very difficult to put in the last sections of the dam.

The triangular frames are braced together in pairs so that each pair will stand by themselves, and being made of light timber they are easily built and placed. If located on hard clay a stake should be driven at the lower end of each rafter, and on rock a hole should be drilled a few inches and an iron pin or a worn-out drill may be driven in the rock.

A dam of this kind 2,000 feet long and 6 feet high was built across one of the channels at the head of Elk River Shoals, which stood through the floods of two winters with but little damage, and such breakage as did occur was caused by heavy logs and other drift, and by the neglect to put in the iron pins, already referred to, as they should have been.

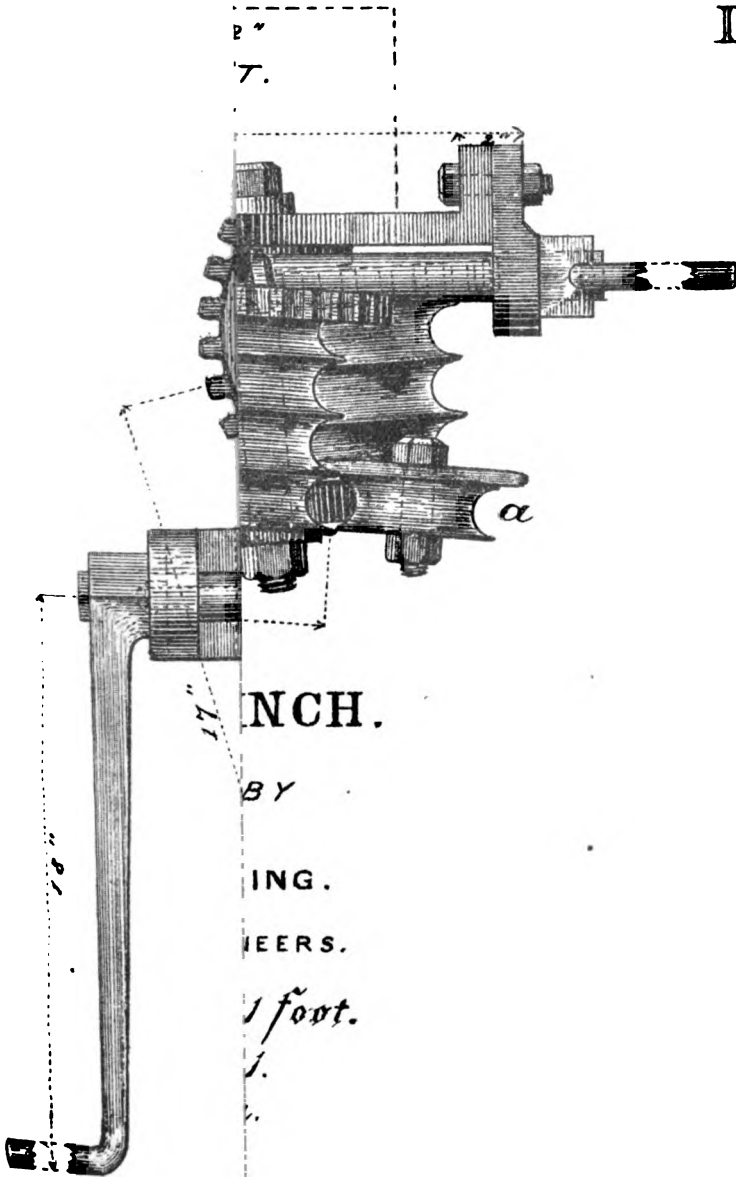
Several hundred feet of such dam can be built in a single day, and as readily removed for use elsewhere.

XII.—APPARATUS FOR TESTING EXPLOSIVES.

In using large quantities of dynamite and Hercules powder it became desirable to have some convenient means of testing the relative strength of compounds furnished by different manufacturers, and the simple apparatus shown on sheet XII was built for this purpose by Assistant Engineer S. Whinery on the Elk River Shoals Division, Muscle Shoals Canal.

A hole was drilled in the bottom of an old anvil and an ordinary striking hammer was so arranged that the explosion of a small quantity of dynamite would cause it

I.



to rise to a greater or less height according to the force of the explosion, the height being marked by a small piece of cork sliding on a wire, as shown in the drawing.

This inexpensive arrangement gave very satisfactory results, and was of material advantage in keeping the explosives up to a proper standard, as it is well known that the manufacturers of the various nitro-glycerine compounds are disposed to make the strength of their powder vary according to the price they are to get for it.

XIII.—DROP GATE FOR MUSCLE SHOALS CANAL LOCKS.

This form of gate was especially designed for wide and shallow openings like the upper gates on the Shoals Canal, where the width is 60 feet and the depth of water only 6 feet, which would make the ordinary miter gate too long and narrow for economical working.

The gate may be made of boiler-iron or timber, and hinged along the coping of the lift-wall, like the ordinary drop-gate; but instead of being supported only at the ends, it is held by four sets of chains, with a heavy weight attached to each, so as to yield slightly to any sudden impact from a moving boat, and thus avoid the enormous strain produced by such impacts upon rigid structures.

At the ends of the gate a tight joint is made by leaving about an inch of free space, and placing a small cylinder of wood or a piece of wrought-iron pipe so that it will be forced by the water into the angle between the wall and gate, thus closing the joint tightly when the gate is closed, but getting entirely out of the way and leaving free space when the gate is moving.

It is intended that the gate shall be but little heavier than its displacement of water, and if made of boiler iron, this will be accomplished by making it in water-tight compartments. Several plans for closing these gates have been considered, but the simplest appears to be by means of a chain attached to the inner edge of the coping at B, and passing down under and thence along the under side of the gate to the opposite side of the lock and up to the top of the coping, where it can be carried over a suitable pulley and back to an adjustable counterpoise placed in a well behind the lock wall.

This chain can pass around a windlass or capstan, and this will give a convenient means of applying the power to close the gate. The chain must of course be supported at intervals by suitable pulleys, and it has the advantage of lifting equally upon the two ends of the gate, and of being maneuvered entirely at one side of the lock.

The center of gravity of this gate has to move only about $5\frac{1}{2}$ feet in opening, while the miter gates for the same lock would have to move $18\frac{1}{2}$ feet, and the gates themselves would have to be very much heavier. A large quantity of masonry required for the gate recesses is saved by using the drop gate.

Y 2.

IMPROVEMENT OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY.

The States of Tennessee and Kentucky, as early as 1830, made appropriations for the survey and improvement of the Cumberland River, and in 1846 a charter was granted to a company by the former State to build locks and dams on the river below Nashville.

A survey of the Cumberland was authorized by Congress in 1870, and a resurvey of that part of the river embracing Smith's Shoals in 1875. Upon these surveys was based the present project for improvement. A survey of the falls of the Cumberland was made in 1879 and a reconnaissance of the Upper Cumberland in 1880.

The Cumberland has been divided in the different river and harbor acts into a number of sections, which will be considered in their order. The obstructions to be overcome are of a similar nature on the different sections, and consist of rock reefs, gravel bars, snags, bowlders, and overhanging trees, and on that part of the river above the Jellico, mainly fish traps and milldams.

The method of improvement consists of blasting out a channel through the rock reefs, removing gravel bars and bowlders, and building riprap dams where a contraction of the waterway is necessary to secure additional depth, and also the removal of snags and overhanging trees.

The improvement of the river by the construction of locks and dams which is the only method by which a low-water navigation can be secured either above or below Nashville, excepting for very light-draught boats has been considered too expensive, and the present project is only designed to give such additional depth to the channel as will prolong the season of navigation.

There are now twenty-one steamboats engaged in commerce on the river, having an average registered tonnage of 183 tons; their individual capacities ranging from 100 to 500 tons. These boats run between Nashville and various points on the Cumberland, Ohio, and Mississippi rivers.

The Cumberland is navigable for all the steamboats for six months of the year, from Nashville to the mouth of the river; and from six to eight months for boats drawing three feet and less, and the entire year for boats of 16 inches draught.

Above Nashville the river is navigable to Point Burnside (the Cincinnati Southern Railway crossing), a distance of 358 miles, for from four to six months, for steamers of 3 feet draught or less, and from two to three months for larger boats. From Nashville to Burksville, 230 miles above, the Cumberland is navigable from five to seven months for steamers of 3 feet draught or less, and from three to five months for larger boats. From Nashville to Carthage, 120 miles above, the river is navigable from six to eight months for steamers of 30 inches draught or less, and from four to five months for larger boats. The work done on the Cumberland, although not completed, has already had the effect of extending the duration of the navigable period, both above and below Nashville.

It is estimated that the following shipments were made on the Cumberland during the past year, namely:

Grain	bushels..	3,000,00
Tobacco	hogsheds..	14,00
Potatoes	barrels..	3,00
Iron	tons..	20,00
Hogs and cattle	head..	10,00
Eggs	dozen..	100,00
Lumber (partly rafted)	feet, B. M..	160,000,00
General merchandise not estimated.		
Passengers carried		125,00

I.—BELOW NASHVILLE.

Work on this section was resumed in September and continued until January, when operations were suspended on account of high water. Work was carried on at the following places, and the condition of the work at the different points is as stated below:

- At Harpeth Shoals, nine-tenths completed.
- At Checkered House Shoals, nine-tenths completed.
- At Elk Creek Shoals, ——— completed.
- At mouth of river, one-half completed.

In addition to the work at the points above mentioned, operations with a snag-boat were carried on during the months of October and November between Nashville and the mouth of the river.

The following are the quantities of work done during the year.

Rock placed in dams.....	cubic yards..	3,397
Rock excavated from channel	do.	78
Gravel excavated from channel	do.	1,550
Snags removed.....		938
Old wrecks removed.....		2
Brush dam built at mouth of river.....	linear feet..	740

The work done on the shoals above mentioned effected an increase in the depth of water, at low stage, of from 6 to 9 inches.

The work was in local charge of Assistant Engineer C. A. Turrill, with an average force of fifty men.

The funds available, and the appropriation herein estimated for, can be profitably expended in continuing work upon the shoals below Nashville in accordance with the present plan.

The original estimate of cost of improving Cumberland River, below Nashville, was	\$248,821 00
Amount appropriated.....	235,000 00
Amount expended	229,731 74

Money statement.

Amount appropriated by act passed August 1, 1882	\$15,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$9,545 99
July 1, 1883, outstanding liabilities	185 75
	<hr/> 9,731 74
July 1, 1883, amount available.....	<hr/> 5,268 26
Amount (estimated) required for completion of existing project	13,821 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	13,821 00

II.—ABOVE NASHVILLE.

FROM NASHVILLE TO FOOT OF SMITH'S SHOALS.

Work on this section, heretofore divided into two sections, was resumed in September and carried on till the close of the fiscal year. The work of building dams was, however, suspended during the winter months in account of high water.

Operations were confined, principally, to the following obstructions:

Old pier removed at Nashville, one-tenth completed.
Upper Nashville Island, completed.
Cricket's Shoals, completed.
Donaldson's Horse Ford, one-half completed.
Windsley's Island, three-fifths completed.
Belote's Bar, completed.
Whitley's Rock Island, completed.
Welbourne's Bar, seven-eighths completed.
Walton's Shoals, completed.

In addition to the work done at the obstructions above mentioned, operations with a snag-boat were carried on during a part of the low-water season between Point Burnside and Albany Landing, 80 miles, and Hartsville and Nashville, a distance of 100 miles.

The following are the quantities of work done on this section during the fiscal year:

Rock quarried for dams.....	cubic yards..	4,700
Rock placed in dams.....	do.	16,184
Rock excavated from channel	do.	245
Gravel excavated from channel	do.	4,845
Snags removed.....		410
Old wrecks removed.....		2
Overhanging trees cut down.....		19

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Work on this section was conducted by Assistant Engineer C. A. Turrill in local charge, with an average force of sixty-two men. Under provisions of the appropriation act of August 2, 1882, a survey of this part of Cumberland River is now in progress with a view to ascertaining "cost of placing locks and dams on the Cumberland River from Nashville, Tennessee, to the Cincinnati Southern Railroad in Kentucky."

The original estimate cost of improving Cumberland River from Nashville to foot of Smith's was.....	\$213, 764 00
Amount appropriated.....	162, 000 00
Amount expended.....	159, 611 77

Money statement.

July 1, 1882, amount available.....	\$3, 392 23
Amount appropriated by act passed August 2, 1882.....	30, 000 00
	<hr/> 33, 392 23
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$27, 806 67
July 1, 1883, outstanding liabilities.....	3, 197 33
	<hr/> 31, 004 00
July 1, 1883, amount available.....	<hr/> 2, 388 23
Amount (estimated) required for completion of existing project.....	51, 764 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	51, 764 00

III.—SMITH'S SHOALS.

These shoals, consisting of Shadowen Shoals, White Cliff Ripple, Long Shoals, and Mill Shoals, having an aggregate fall of 55 feet in 8 miles, form the most serious obstruction to navigation between the Great Falls and the mouth of the Cumberland, an estimated distance of 591 miles.

The original plan of improvement was based on a survey made in 1875. The method adopted for the improvement of the channel was to deepen it and make it as smooth as practicable by excavating through the reefs and removing bowlders, and to contract the channel, and change the direction of the current where necessary, by the construction of rip-rap dams.

Work on these shoals was resumed in September and carried on until the latter part of February, when the work according to the existing project was completed.

The work during the year was confined to Long and Mill Shoals, and consisted in the strengthening, and in some cases the extension, of the dams originally built, and also in excavating loose and solid rock from the channel, and quarrying stone for the enlargement of the dams.

The quantities of work done are as follows:

	Cubic yards.
Rock excavated from channel.....	655
Earth stripped from quarries.....	798
Rock quarried for dams.....	3, 424
Rock placed in dams.....	4, 129
Concrete placed in dams.....	35

Assistant Engineer W. C. Crozer, was in local charge, with an average force of fifty-four men, and he reports that these shoals are now in as good condition as the shoals above, and consequently as available for navigation. The improvement has increased the depth of water in the channel from 18 to 24 inches on what was formerly a 50-inch tide. Four coal boats and two stone-boats passed over the shoals between January 21 and April 18, drawing from 52 to 54 inches, and without the least difficulty.

The total estimates for the improvement of Cumberland River at Smith's Shoals.....		\$100,000 00
Amount appropriated.....		115,000 00
Amount expended.....		114,228 50

Money statement.

July 1, 1882, amount available	\$254 63
Amount appropriated by act passed August 2, 1882.....	15,000 00
	15,254 63
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$14,475 83
July 1, 1883, outstanding liabilities	7 30
	14,483 13
July 1, 1883, amount available	771 50

IV.—CUMBERLAND RIVER ABOVE THE MOUTH OF JELlico, KENTUCKY.

No work has been done on this section during the year for the reasons given in my last annual report, namely:

It is proper here to report that the State of Kentucky has during the last session of the legislature chartered a company to build locks and dams on this part of the Cumberland, with power to condemn mills, dams, and other real estate, and to collect tolls for the navigation of said river for fifty years. The act also provides that the company may begin operations at any time within three years, and before doing so they must pay to the county courts of Whitley, Knox, and Bell counties the sum of \$2,666 each, "which amount had been expended in clearing out the obstructions and improving the navigation in said counties."

In accordance with my recommendation, approved by the Chief of Engineers, an examination of the mill dams, which form the chief obstructions to navigation in this part of the river, was made in June last by Assistant Engineer W. C. Crozer, from whose report the following information was obtained, namely:

Dam No. 1.—Located at Pineville, Ky. Owned by James J. Gibson. Built more than fifty years ago. Authority unknown. Estimated value, \$1,000. Length, 100 feet, and built of loose rocks thrown in above natural boulders in river bed. Height, 20 inches. Width of log-chute, 100 feet when there is a "log-tide." Mill small and inexpensive. Has ground 60 bushels of corn in twelve hours. This dam is no obstruction to rafts and logs.

Dam No. 2.—Located $6\frac{1}{2}$ miles below Pineville. Owned by Oliver P. Ely. Original dam built about fifty years ago; present one over twenty years ago. Authority, stream had not been declared navigable at time of building. Estimated value, \$3,700. Length, 319 feet. Height, 3 to 7 feet. Built of log cribs filled with stone. No log-chute when dam is in repair. Capacity of mill, 70 to 80 bushels in twelve hours.

Dam No. 3.—Located 6 miles above Barbourville. Owned by B. F. Main. First built in 1869 and rebuilt in 1877. Authority, none. Estimated value, \$500. Length, 258 feet. Height, $3\frac{1}{2}$ feet. Built of log cribs filled with stone. When in repair no log-chute. Furnishes power for a small grist-mill.

Dam No. 4.—Located at Barbourville. Owned by Peter Hinkle and John Dishman. Originally built about seventy years ago; present dam built in 1877. Authority, none but age. Estimated value, \$3,600. Length, 197 feet. Height, 4 to 8 feet. No log-chute. Built of log cribs filled with stone, and in part consists of a solid ledge of rock. Runs a small grist-mill.

Dam No. 5.—Located 16 miles by river, below Barbourville. Owned

by James McNeal. Built in 1846. Authority, mill-site condemned by county court. Estimated value, \$1,000. Length, 174 feet. Height about 6 feet. Built of log cribs filled with stone. No log-chute. Runs a small grist-mill.

Dam No. 6.—Location, 4 miles below Dam No. 5. Owned by John F. Evans. Built in 1879. Authority, none. Estimated value, \$150. Length, 136 feet. Height, 4 feet. Built of log cribs filled with stone. No log-chute. Used to run a small grist-mill.

Dam No. 7.—Located at London, Ky. Owned by John P. Finley. Built about 1848. Authority, mill-site condemned by county court. Estimated value, \$1,500. Length, 158 feet. Height could not be measured owing to the depth of water on it at the time. Built of log cribs filled with stone. No log-chute. Runs a small grist-mill.

Dam No. 8.—Located 10 miles below London. Owned by Mrs. L. D. Sutton. Original dam built 300 feet above this seventy years ago; present dam built in 1852. Authority, Whitley county court. Estimated value, \$1,500. Length, 226 feet. Height, 6 feet. Built of log cribs filled with stone. No log-chute when dam is in repair. Used to run a small grist-mill.

Dam No. 9.—Located at Williamsburg, Ky. Owned by A. C. King. First dam built in 1857, present dam in 1882. Authority, Whitley county court. Estimated value, \$1,200. Length, 300 feet. Height, 9 feet. Built of log cribs filled with stone and planked over. No log-chute. Runs a small portable grist-mill.

Dam No. 10.—Located 12 miles by water below Williamsburg. Owned by Joseph L. Jones. First built about one hundred years ago, present dam about forty years ago. Authority, county court. Estimated value, about \$300. Height, 2½ feet. Built of log cribs filled with stone. No log-chute when in repair. Runs a small grist-mill.

Dam No. 11.—Located one mile above the mouth of the Jellico River. Owned by G. M. Parks. First built about twenty years ago; present dam built in 1881. Authority, county court. Estimated value, \$800. Length, 434 feet. Height, 6 feet. Built of log cribs filled with stone, and planked over. No log-chute. Runs a small grist-mill.

It should be noted that several of these dams have gaps in them caused by the floods, and that if they were entirely removed the river would not be as much improved as would at first appear, since the rapids and reefs upon which the dams are generally built and others now flooded by the mill-ponds would doubtless become almost as formidable obstructions as the dams themselves.

The estimate for improving the Cumberland River above the mouth of Jellico, Kentucky, was		\$50,000 00
Amount appropriated		15,000 00
Amount expended		9,272 44

Money statement.

July 1, 1882, amount available	\$1,063 89
Amount appropriated by act passed August 2, 1882	5,000 00
	6,063 89
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$216 67
July 1, 1883, outstanding liabilities	119 66
	336 33
July 1, 1883, amount available	5,727 56
Amount (estimated) required for completion of existing project	35,000 00

Y 3.

IMPROVEMENT OF HIWASSEE RIVER, TENNESSEE.

The improvement of this river is based on an examination made in 1874, from Savannah Ford to its mouth, a distance of 30 miles. The plan adopted consists in excavating a channel through the rock and gravel bars, and building dams where necessary, so as to afford 2 feet depth of water for a minimum width of 40 feet at low water.

Active operations were carried on during September, October, and November, under the local charge of Assistant Engineer John S. Crary, by hired labor. The work of previous seasons was taken up at Gamble's Shoals and carried through to Savannah Ford. Sixty-five cubic yards of solid rock, and 219 cubic yards of bowlders were excavated from the channel; 104 cubic yards of riprap dam built and eighty-two snags removed.

The Standing Rock and the overhanging rock under which many rafts had been wrecked were completely removed. An additional depth of at least 10 inches was obtained on all the shoals upon which work was done. Parties living near the river report a large increase in the shipments, and have kindly furnished the following partial statistics of its commerce, namely:

66,336 bushels of grain.

743 bales of cotton.

5,000 bushels cotton-seed, &c.

Besides large quantities of lumber, and rafts of saw-logs.

The commerce is partly carried on by steamboats from the Tennessee River, and partly by flat and keel boats.

The appropriations for this river have been so small for several years past that a considerable portion of it has necessarily been expended in taking care of the plant, and other constant expenses, whether much or little be done. This has made the work actually done cost excessively, and it cannot be otherwise with such small appropriations. This river is now in a fair boating condition, and I would therefore respectfully recommend an appropriation of at least \$5,000, or that the work be kept in its present condition until Congress deems it advisable to make such an appropriation.

The tools and other property have been removed to the Tennessee River, where a part of them can be used, and the balance stored until they are again required for the Hiwassee, without expense to the latter.

Total estimate of cost of improving Hiwassee River	\$34,000 00
Amount appropriated	29,000 00
Amount expended	28,868 47

Money statement.

July 1, 1882, amount available	\$31 98
Amount appropriated by act passed August 2, 1882	1,500 00
	<hr/> 1,531 98
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$1,382 71
July 1, 1883, outstanding liabilities	17 74
	<hr/> 1,400 45
July 1, 1883, amount available	131 53
	<hr/>
Amount (estimated) required for completion of existing project	5,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	5,000 00

Y 4.

IMPROVEMENT OF FRENCH BROAD RIVER, TENNESSEE.

The French Broad River enters the State of Tennessee at Paint Rock, and after a course of 121 miles empties into the Holston River, $4\frac{1}{2}$ miles above Knoxville. From the junction of the Nolichucky up to the State line the French Broad is not susceptible of improvement, except by slack-water navigation at enormous cost. After receiving the waters of the Nolichucky, its character changes to a broad and beautiful stream, well adapted to navigation. The present plan of improvement is based upon an examination made in 1876, and consists in removing the obstructions from the channel, cutting overhanging trees, and building wing-dams where necessary, so as to permit the passage of vessels drawing $2\frac{1}{2}$ feet of water as high as Leadvale during the low-water season. Active operations were carried on by hired labor, under the local charge of Assistant Engineer John S. Crary, from July, 1882, to January, 1883, when work was suspended, the available funds being exhausted.

At Green's Shoals the little work necessary was completed. At Sewee Mill Shoals two training-dams were constructed and the water deepened from 12 inches to 28 inches at the head, and from 16 to 42 inches at the foot. At Campbell Mill Shoal a retaining-wall was built 408 feet long and an old fish-dam torn out, increasing the depth of water 10 inches. At Bowman's Shoal an old fish-dam was torn out and the rock put on the old State dam.

At Pickle's I-land was found the most serious obstruction in this part of the river, and it was deemed best to open the slough back of the island and partly close the other with a stone and brush dam. Work here was about three-fourths done when operations were suspended. Ascending boats use the new channel, although the old one is open for use. The work done gives good satisfaction to those navigating the river.

Stone quarried	cubic yards..	1,386
Riprap dams built	do.....	3,871
Solid rock excavated from channel	do.....	4
Boulders excavated from channel	do.....	165
Overhanging trees cut .....	.....	74
Snags removed .....	.....	55
Brush used in dams	cords..	75

An appropriation of \$15,000 can be profitably expended next season in carrying forward this work according to the present project.

The commercial statistics for the period of operations (July to January) are as follows:

Sawed lumber	feet, B. M..	541,000
Rafts of logs	number..	12
Grain	bushels..	21,271
Wood and tan bark	cords..	268
Produce	tons..	269
Merchandise	do...	164

From Leadvale to the North Carolina State line no estimate has been made for the improvement of this river.

The original estimate of cost of improving French Broad River from Dan- dridge to its mouth was	\$150,000
Amount appropriated	18,500
Amount expended	18,500

Money statement.

July 1, 1882, amount available.....	\$1,464 59
Amount appropriated by act passed August 2, 1882	5,000 00
	<hr/> 6,464 59
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$6,436 72
July 1, 1883, outstanding liabilities	27 87
	<hr/> 6,464 59
Amount (estimated) required for completion of existing project.....	131,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	15,000 00

Y 5.

IMPROVEMENT OF CLINCH RIVER, TENNESSEE.

After a course of about 100 miles in Virginia, the Clinch River enters Tennessee and pursues a general southwesterly course for over 230 miles, and enters the Tennessee River at Kingston, Tenn. The area drained by the Upper Clinch is about 1,436 square miles, a large portion of which is isolated from railroad facilities by parallel mountain ranges.

From 1830 to 1845 the State of Tennessee expended considerable sums of money in the improvement of this stream, but most of the work was done by contract, under a loose system of supervision, and not being well done, has been greatly damaged or destroyed. The commerce of the river increased to such an extent as to outgrow these primitive improvements. From an examination made in 1875, the present plan of improvement was adopted. With the progress of these improvements the commerce of the river increased so rapidly that it became necessary to increase the width of the channel to nearly double the width originally estimated as necessary.

The plan of improvement adopted is to remove the most dangerous obstructions down to extreme low-water mark, blasting a chute through the ledges and building wing and training dams where necessary, so as to secure at ordinary low water a depth of 2 feet from Kingston to Clinton, 70 miles, and $1\frac{1}{2}$ feet from Clinton to Haynes, 75 miles.

Active operations were continued during the year under the local charge of Assistant Engineer W. G. Sanborn, with an average force of about eighteen men, two parties working until November, and since then one party.

Work was carried on at many places in the 110 miles from Straight Shoals to Black's Shoals—the most important *above Haynes* being Straight Shoals and Hunter's Shoals—strong stone dams being built from the left shore out and through the shoals and the channel widened and deepened by excavating the solid rock. Work here was completed and navigation made safe with 2 feet lower stage than before.

Below Haynes.—The most important improvements were made at Bletcher's Shoals, Cloud Shoals, and Llewellyn Shoals.

Bletcher Shoals were the most obstructive and dangerous of any on the river. As the improvements were being started at these shoals, the assistant engineer observed that 50 per cent. of all the rafts and boats that attempted to pass through them were more or less injured, and part were entirely torn to pieces.

Since the improvement neared completion everything has passed safely through these shoals. A very strong wing and training dam has been built from the left shore down through the worst part of the shoals, and a channel, 120 feet to 150 feet wide, blasted through the ledges. This work is still in progress.

At Cloud Shoals and Llewellyn Shoals the work done was of the same kind, but of less extent.

The extent of work, and its location at each shoal, was carefully determined from numerous gauges and measurements, and thus all unnecessary work was avoided, and all expense concentrated on useful work upon a defined plan.

The following was the work done during the fiscal year:

Solid rock excavation	cubic yards..	927
Loose rock excavation	do.....	849
Gravel excavation	do.....	1,624
Old dams, excavation	do.....	578
Earth embankment	do.....	1,526
Stone quarried	do.....	3,208
Riprap dam built	do.....	4,666
Timber in dams	feet B. M..	12,000
Snags removed		152
Overhanging trees cut down		32

Merchants, manufacturers, farmers, and river men generally have promptly utilized the improvements as fast as they became available and have tried to bring down their loaded boats when the river was less than 6 inches above extreme low water. They passed safely through the improved shoals, but were detained some, and finally stopped at shoals that had not been improved for want of available funds.

The commercial statistics for lumber and grain are derived mainly from the records of the assistant engineer, for the years 1881, 1882, and 1883. Saw-mill men and river men generally estimate the number of rafts from two to four times the number herein reported.

Rafts number 2,493, containing 197,726 logs, which estimated at 250 feet B.

M. each	feet B. M..	49,181,500
These rafts were partly loaded with sawn lumber	do.....	1,000,000
Grain and potatoes	bushels..	53,000
Flat-boats laden		350

Of this number:

40 flat-boats carried zinc ore	tons..	2,000
4 flat-boats carried hickory timber	do.....	200
160 flat-boats carried lumber (black walnut)	feet B. M..	5,300,000
120 flat-boats carried grain	bushels..	200,000
20 flat-boats carried sundries	tons..	1,010
Families moving with their household goods, &c		6

Shipments made on five steamboats plying on the river aggregated:

Grain	bushels..	110,000
Flour and potatoes	barrels..	2,550
Bacon, &c	tons..	400

In addition, three steamboats and thirteen barges moved:

Coal	bushels..	70,000
Iron ore	tons..	35,000

At Bletcher's Shoals above the mouth of Powell's River (a very important tributary of the Clinch) the assistant engineer observed fifty-one rafts and boats pass in one hour, sixteen being on the shoal at one time, six overlapping each other. In twelve consecutive hours, one hundred and sixty rafts and boats pass through, and at another time one hundred and eighty-one rafts, &c., on which were over 1,000 people.

The balance on hand and the amount herein estimated for can be

profitably expended in continuing operations under the existing project and in view of the increase in commerce on this river it is probable that a considerable additional work will be justified in the near future.

The original estimates for improving Clinch River, Tennessee	\$26,400 00
Amount appropriated	16,000 00
Amount expended	15,464 90

Money statement.

July 1, 1882, amount available	\$5,502 00
Amount appropriated by act passed August 2, 1882.....	3,000 00
	8,502 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$7,369 24
July 1, 1883, outstanding liabilities	597 66
	7,966 90
July 1, 1883, amount available.....	535 10
Amount (estimated) required for completion of existing project.....	10,400 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	10,400 00

Y 6.

IMPROVEMENT OF DUCK RIVER, TENNESSEE.

Duck River rises in the Cumberland Mountains in Middle Tennessee, flows a little north of west and empties into the Tennessee River, 14½ miles above Johnsonville.

The State did not attempt to improve this river with its own funds but authorized its improvement by incorporated companies at three different times. Some work was done under one of these charters, but no practical results were attained until the present project was adopted, based upon an examination made in 1879. This plan embraced the removal of the obstructions in the channel, closing chutes, revetting the shore where necessary, cutting overhanging trees, and building brush and riprap dams, so as to confine the water and cause it to scour out the gravel bars, and thus secure 2½ to 3½ feet of water in the channel for from four to six months of the year, which would answer all the present requirements of commerce.

Active operations were carried on by hired labor for five months under the local charge of Assistant Engineer J. E. Turtle. This season's work completed the improvement of this river from Centreville to its mouth; a distance of 68 miles according to the adopted plan, and the work may generally be regarded as permanent; yet there are a few important shoals that may require additional work in the near future.

Work was done on twenty-one shoals. At Blue Rock, the channel was widened 30 feet by blasting out the solid ledge. Five Island Shoals were the most difficult and dangerous on the river; they were improved by removing snags, constructing two dams, and excavating a small island, and no further trouble need be apprehended there; care was taken to make this work permanent. At Hurricane Creek the log and brush dam built in 1881 was found intact, and it was extended so as to close the right or crooked chute, and throw the water into the left or straight chute.

The following work was done this season :

Rock excavated from channel	cubic yards..	53
Gravel excavated from channel	do.	567
Earth excavated from channel	do.	1, 637
Earth stripped from quarry	do.	44
Stone quarried	do.	734
Stone placed in dams	do.	781
Snags removed		646
Overhanging trees cut		528

The river is now in a fair navigable condition from Centreville to its mouth. A steamboat has been built this season especially for navigating this river.

The commercial statistics are very incomplete. Two steamers carried out most of the produce below Hurricane Branch, namely, 50,000 sacks of grain.

River men report that the improvements have greatly benefited the navigation of this river.

The available funds for this work having been nearly exhausted the boats and tools were laid up, and, in order to avoid the expense of watchmen for an indefinite period, no additional appropriation having been made, application was made to the Chief of Engineers for authority to sell this property and turn the proceeds into the Treasury, which will be done at an early day, the application having been approved.

Although the work contemplated in the existing project has not all been done, it is believed that the improvement accomplished will answer all the present needs of commerce, for several years at least, and it is therefore respectfully recommended that, unless Congress deems it expedient to appropriate at least one-half of the sum estimated for as necessary to complete the existing project, no further appropriation be made at present.

The original estimate of cost of improving Duck River was	\$35, 118 00
Amount appropriated	13, 000 00
Amount expended	12, 880 38

Money statement.

July 1, 1882, amount available	\$1, 776 25
Amount appropriated by act passed August 2, 1882	3, 000 00
	<hr/> 4, 776 25
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$4, 543 08
July 1, 1883, outstanding liabilities	113 55
	<hr/> 4, 656 63
July 1, 1883, amount available	119 62
Amount (estimated) required for completion of existing project	22, 118 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	10, 000 00

Y 7.

IMPROVEMENT OF OBEY'S RIVER, TENNESSEE.

This stream empties into the Cumberland River at Celina, Tenn., about 3 miles below the Kentucky State line.

Barnes' Landing is the present head of navigation, but small boats have ascended to Eastport, at the Fork of Obey's, some 18 miles above.

From an examination made in 1879, from Barnes' Landing to its mouth, 43 miles, the obstructions were found to be the usual ones in this region, of snags, overhanging trees, rock and gravel bars, and bowlders.

The plan of improvement provides for the removal of these obstructions and the building of wing-dams, so as to secure safe navigation for small steamboats and rafts during boating tides for four or five months of the year, which will give all the facilities needed for some time.

Mr. C. A. Turrill, assistant engineer, has had local charge of this work, with an average force of thirty-seven men, and commenced active operations by hired labor on June 1, and the work is now in progress. Improvements were carried forward at three places, namely: Reef reduced at Johnson's Ford, two riprap dams finished at Ford's Island, and 220 cubic yards of stone quarried for dams at Gamewell's Island; 63 cubic yards of rock and 481 cubic yards of gravel have been excavated from the channel, and 418 cubic yards riprap dam built. A snag-boat worked down-stream, from Eastport to West's Island, about 20 miles, removing from the channel 41 cubic yards of rock and seventeen snags, and cutting down twenty-one overhanging trees.

About two-thirds of the projected improvements have been completed, and it is expected the work will be entirely completed within four months.

The total amount expended to June 30, 1883, is \$7,842.65, and, as the balance of the appropriation, \$3,657.35, is deemed sufficient to complete the improvements required by the limited commerce, no further appropriation is asked for.

Raftmen appear to be satisfied with the improvements that have been made.

About three hundred rafts of logs descended this river during the year. No steamboats ascended this year, but one is expected to ply on this stream next winter.

Original estimate of cost of improving Obey's River	\$11,869 00
Amount appropriated	11,500 00
Amount expended	7,842 65

Money statement.

Amount appropriated by act passed August 2, 1882	\$5,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$4 20
July 1, 1883, outstanding liabilities	1,338 45
	<hr/> 1,342 65
July 1, 1883, amount available.....	3,657 35

Y 8.

IMPROVEMENT OF CANEY FORK RIVER, TENNESSEE.

This stream flows wholly in the State of Tennessee. It rises in the table-land of the Cumberland Mountains, about 18 miles east of Sparta, and enters the Cumberland River near Carthage, Tenn. The head of navigation is at Sligo's Ford, about 80 miles from its mouth, and the fall in that distance is about 50 feet. An examination was made by the United States in February, 1879, from the mouth of the river to the head of navigation. The obstructions were found to be gravel-

1500 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

reefs, logs, snags, and overhanging trees, with a crooked channel at several points, making navigation insecure at all times, and having about 3 feet 5 inches of water at the numerous shoals; at a stage of 3 feet above low water.

The plan of improvement is to remove channel obstructions and build wing-dams, so as to enable steamboats of not more than 3 feet draught to ply to and from Nashville for about five months in the year, when the Cumberland River is usually at a good boating stage—from February to July.

The first appropriation, \$6,000, was made in 1880, and again, in 1881, \$4,000 was appropriated. By act of August 2, 1882, another \$4,000 was available near the close of the then working season, but the unusually high stage of water rendered it impracticable to successfully and economically renew active operations until the 1st of June, the last month of the fiscal year. A snag-boat was then started down-stream from Eagle Creek, about 4 miles below Sligo's Ferry, to clear the channel of the drift and snags accumulated by the winter's floods. At the end of June the snagging party had reached Mine Lick Island, thus working over a reach of about 18 miles of river, and had removed fifty-eight snags and stumps, cut down one hundred and seven overhanging trees, and girdled two hundred trees on the caving banks. Several of the island chutes were also trimmed of obstructing bushes.

At *Hall Rock Island* about 775 cubic yards of gravel were put in a dam, which is to be about 500 feet long.

At *Trousdale's Ferry Bar* a riprap dam about 600 feet long will be built, and for which 250 cubic yards of stone were quarried in June.

The work already done upon this stream has materially improved the navigable channel, and it is reported by steamboat men to be satisfactory, giving them a safe channel of an average increased depth of about 7 inches at a stage of 3 feet above low water.

Steamers from the Cumberland River have made fifteen trips up the Caney Fork during the past year. A large increase of commerce, chiefly produce and grain, and including 200,000 bushels of corn, is reported as reaching a market at Nashville, with return cargoes of miscellaneous merchandise to Sligo's Ford and intermediate points, but no detailed data as to quantities can be readily obtained.

The appropriation of \$16,228 asked for the next fiscal year can be profitably applied in removing reefs, building wing-dams, cutting overhanging trees, and largely in clearing the channel, for the Caney Fork, being a mountain stream, is subject to heavy floods. Its caving banks and consequent snags and drift will require such work to be done, more or less in extent, from year to year.

Amount estimated for improving Caney Fork River.....	\$30,228 00
Amount appropriated	14,000 00
Amount expended.....	10,966 07

Money statement.

Amount appropriated by act passed August 2, 1882	\$4,000 00
July 1, 1883, outstanding liabilities	966 07
July 1, 1883, amount available.....	3,033 93
Amount (estimated) required for completion of existing project.....	16,228 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	16,228 00

Y 9.

IMPROVEMENT OF COOSA RIVER, GEORGIA AND ALABAMA.

The improvement of the navigation of the Coosa River, with the view to its connection with the waters of the Tennessee, was under consideration as early as 1823, when the State of Alabama passed an act to aid in the proposed work, which act was formally approved by Congress the following year, and later, in 1828, Congress provided that any surplus of the grant for improving Tennessee River should be applied to the improvement of the navigation of the Coosa, Cahaba, and Black Warrior rivers.

The improvement of the navigation of the Coosa, notwithstanding the early consideration of the subject, seems to have been neglected until quite recent years.

In 1870 an examination of the Coosa, between Greensport and the Selma, Rome and Dalton Railroad Bridge, a distance of 77 miles, was authorized by an act of Congress, and in 1872 an instrumental survey was made of this part of the river, upon which to base plans and estimates for its improvement.

In 1875 an examination of the river was made from Rome, Ga., to Gadsden, Ala., a distance of 135 miles, when a plan for its improvement was adopted (which was subsequently modified), providing for a channel 80 feet wide and 4 feet deep at extreme low water.

In 1876 an appropriation was made for improving the Coosa River, between Rome and the Selma, Rome and Dalton Railroad Bridge, which dates the beginning of the improvement of this river according to a fixed and systematic plan.

Active operations have been carried on each year since the beginning of the work, and the improvement is now far advanced.

A channel 3 feet deep, at least, at extreme low water, is contemplated in the projected improvement.

Work on the channel between Rome and Greensport has been suspended, in order that the more serious obstructions below Greensport may be disposed of first, or carried so near completion as to permit the opening of the entire river embraced in the present project of improvement at or about the same time.

The obstructions below Greensport consist in a succession of very broad and shallow reefs, extending over 5 miles of the river, and having a total fall of 24 feet, the greater part of which is confined to a length of about 2 miles. This part of the river, 5 miles in length, embraces Whisternant's Shoals and Ten Island Shoals, the improvement of which requires a far more costly and extended work than will be necessary on any other part of the river included in the present project for improvement. The plans for improving these shoals are as follows:

First. A longitudinal dam 2,000 feet long, forming a canal, with a lock at the lower end.

Second. A dam 1,100 feet long across the river, terminated at one bank by another lock.

Third. The utilization of a natural chute as part of the canal, placing a dam and third lock at its lower end.

Operations during the year have been confined to the works above

mentioned and to opening the channel through Lonnergan's and Hart's reefs, below Lock No. 3.

The following are the quantities of work done during the fiscal year ending June 30, 1883:

	Cubic yards.
Stone quarried for locks.....	1, 319
Stone cut for Locks Nos. 2 and 3.....	473
Masonry laid, cut stone and rubble.....	239
Dry rubble in dam Lock No. 2.....	4, 689
Stone quarried for riprap dams.....	5, 894
Stone and gravel placed in riprap dams.....	18, 597
Earth excavation.....	2, 106
Channel excavation, solid rock.....	359
Channel excavation, loose rock and gravel.....	1, 140

In addition to the above a boom was constructed just above Lock 1 to prevent the accumulations of drift wood, and three barges were built for use in boating stone to the dams, besides other miscellaneous work.

The condition of the improvement on June 30, 1883, was as follows:

Lock No. 1.—Masonry completed, and the lock is ready for the gates. The longitudinal dam and short spur-dam connecting with this lock are also complete, 2,570 cubic yards of stone having been placed in these dams during the year.

Lock No. 2.—Masonry completed; also the dry rubble dam, 1,100 feet long, extending from the upper end of the lock to the opposite shore of the river.

Work on the dams connecting the lower end of this lock with Wood's Island was continued during the year and is now about completed.

Lock No. 3.—All of the stone required for this lock has been cut. A coffer-dam, inclosing the lock-pit, has been constructed, and the foundation excavated, which is now ready for the masonry.

No masonry has yet been laid, owing to certain difficulties in the way of acquiring a title to the site of the lock.

The work was under the local charge of Assistant Engineer M. T. Singleton, with an average force of one hundred and twelve men.

In addition to the usual trouble experienced on this part of the work during the fall months on account of the prevalence of malarial fevers, the work was further retarded by an outbreak of small-pox in the working force in December, 1882. Prompt measures of quarantining and vaccination were resorted to, which, in addition to the isolation of the infected, held the disease under control, and finally suppressed it altogether.

A resurvey and maps of lands needed by the United States in connection with the construction and maintenance of the canal was made during the year by the engineer party on the work.

The balance on hand and the amount herein estimated for can be profitably expended in completing Lock No. 3, putting in lock-gates, and continuing the improvement at other points on the river between Rome and the Selma, Rome and Dalton Railroad Bridge.

Five steamers ply on this river, and are employed in the heavy lumber, iron, and cotton trade, and in the transportation of passengers and general merchandise between Rome, Ga., and Gadsden and Greensport, Ala. Two tugs are also employed in towing logs to the mills at Gadsden.

Original estimate of cost of improving Coosa River, Georgia and Alabama..	\$562, 347
Amount appropriated	368, 700
Amount expended.....	320, 683

Money statement.

July 1, 1882, amount available.....	\$17,857 21
Amount appropriated by act passed August 2, 1882.....	83,700 00
	<hr/> 101,557 21
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$49,698 44
July 1, 1883, outstanding liabilities.....	3,841 77
	<hr/> 53,540 21
July 1, 1883, amount available.....	48,017 00
	<hr/>
Amount (estimated) required for completion of existing project.....	183,647 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	150 000 00

Y 10.**IMPROVEMENT OF OOSTENLAULA AND COOSAWATTEE RIVERS, GEORGIA.**

These streams are in Northwestern Georgia. Examinations were made in 1872 and 1874 for a distance of about 105 miles from Carter's Mills, on the Coosawattee, to the mouth of the Oostenaula, at Rome.

The plan of improvement was to remove the obstructions, consisting of rock, reefs, gravel bars, snags, and overhanging trees.

No work was done nor expenditure made on either stream during the last fiscal year, and there does not appear to be any commercial necessity for any further improvement than that which can be accomplished with the amount appropriated by act of August 2, 1882, \$1,000, which is to be applied in removing the abandoned bridge piers near Rome, and such other work as can be done to advantage near the mouth of the Oostenaula, so soon as a working force can be economically fitted out and certain necessary action taken by the owners of the bridge piers.

A fair navigable channel is secured on these streams for nine months of the year, that in the Coosawattee having a depth of 2 feet, and that in the Oostenaula having 3 feet of water, about all that can be accomplished without slackwater navigation.

Therefore, no further appropriation is asked for, nor plan submitted.

Estimates of cost for improving these rivers	\$28,208 50
Amount appropriated	26,000 00
Amount expended.....	24,858 14

Money statement.

July 1, 1882, amount available	\$141 86
Amount appropriated by act passed August 2, 1882.....	1,000 00
	<hr/> 1,141 86
July 1, 1883, amount available.....	

Y 11.**IMPROVEMENT OF OCMULGEE RIVER, GEORGIA.**

During the first half of this century the State of Georgia made appropriations for this stream amounting to at least \$60,000.

The Ocmulgee joins the Oconee about 10 miles below Lumber City, the two forming the Altamaha, the principal water highway of the State, which empties into the Atlantic Ocean.

The first examination and survey of the Ocmulgee made by the United States was in 1852. Another examination was made in 1875 from Macon to the mouth of the river.

The obstructions to navigation consist of occasional reefs, snags, logs, sunken rafts, and overhanging trees. The banks are not at all stable, owing to the character of the soil and the great rapidity of the current during freshets.

Active operations with two steam snag-boats were resumed by hired labor in the early part of October. The river was worked over from Dodge's Boom to its mouth, a distance of 25 miles, when at the end of the month the snag-boats ascended the Oconee for similar operations on that river, namely, removing snags, logs, and overhanging trees. On the 13th of December the snag-boats and working force returned from the Oconee and began operations at Tillman's Bar, building two jetties, constructed of logs, brush, and stone, for the purpose of contracting the water-way and thereby securing an increased depth of water.

The work at Tillman's Bar having been completed, the two snag-boats and working force in the early part of April moved up the river, 38½ miles, clearing obstructions from the channel, and building a dam at Indian Timber Landing, and two dams at Ashley's Landing, constructed of logs and snags taken from the channel. During the first half of May the force was employed between Jacksonville and Hubbard's Shoals, removing snags and overhanging trees, working principally at "Red Bluff" and "Big Eddy." On the 15th of May the working force and snag-boats were transferred to the Oconee, to begin operations at Carr's Shoals.

The work done on the Ocmulgee during the fiscal year was as follows:

58 snags and 32 overhanging trees removed.
3 log dams built.
2 jetties built, in the construction of which there were used 220 cords of brush, 291 cubic yards of stone, and 80 piles (10 by 10 by 28 inches).

The working force was also employed in cutting wood for the engines of the snag-boat, and in calking and strengthening the boats.

This work was carried on under local charge of Assistant Engineer C. A. Locke, with an average force of twelve men.

Four steamboats ply on this stream. Their cargoes consist of cotton, provisions, lumber, turpentine, and rosin. According to information received from various sources, over 100,000,000 feet, B. M., of lumber and timber was sent out of the Ocmulgee and Oconee during the year ending July 1, 1882, the greater part of which was from the Ocmulgee. Messrs. B. Stansel and Company, manufacturers of naval stores, estimate that 12,750 barrels of rosin and 2,310 barrels of turpentine will be produced on this river during the current year.

A new steamboat, William M. Wadley, has just been launched at Dublin, on the Oconee, which is to be run on that river and Ocmulgee. Size of hull 22 by 105 feet. Two engines, with cylinders 10 by 48 inches.

The appropriation herein asked for (\$10,000) can be profitably applied to continuing operations with the snag-boats, removing surface obstructions, and building booms or crib-work at a few points, to assist rafts in keeping the main channel.

The work done may be classed as of a permanent character when compared with like work on many of our alluvial rivers, though, as stated in former reports, the nature of the obstructions is such that there is no relation between the work originally estimated for and that done and to be done to secure and maintain good navigation. The

heavy timber often found on the caving banks forms new snags, which result in new bars, and thus will require considerable outlay from year to year to maintain a safe channel.

The estimates for improving Ocmulgee River from Macon to its mouth were. \$81,240 00
 Amount appropriated 54,000 00
 Amount expended..... 52,840 81

Money statement.

July 1, 1882, amount available.....	\$200 51
Amount appropriated by act passed August 2, 1882.....	5,000 00
	<hr/> 5,200 51
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$4,037 84
July 1, 1883, outstanding liabilities.....	3 48
	<hr/> 4,041 32
July 1, 1883, amount available.....	1,159 19
	<hr/>
Amount (estimated) required for completion of existing project.....	27,240 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	10,000 00

Y 12.

IMPROVEMENT OF OCONEE RIVER, GEORGIA.

This river has its origin in Northeastern Georgia, and passing by Milledgeville and Dublin, joins the Ocmulgee in the southern part of the State, these two rivers forming the Altamaha.

The improvement of the Oconee until within the last few years was under the direction of the State of Georgia, which appropriated from time to time during the first quarter of this century sums amounting to over \$35,000.

The first examination of this river by the United States was made in 1874. The obstructions consist of a few rock reefs, but chiefly of bars formed by sunken logs, snags, and overhanging trees. These obstructions are a great drawback to the commerce along the river, particularly in the vicinity of Dublin, a town situated about 80 miles from the mouth of the river, and dependent entirely on river and wagon transportation.

It is proposed to remove all obstructions from the channel, blasting through the rock reefs where necessary to secure a depth of 3 feet at low stage of the river.

Active operations with two steam snag-boats were resumed in the early part of October, beginning at the mouth of the river and working up to Dublin, a distance of about 80 miles. The work accomplished by these snag-boats was of great benefit to navigation below Dublin; the channel at many points was made navigable, which previously was impossible on account of the presence of snags and logs. On the 12th of December operations below Dublin were suspended on account of the exhaustion of funds applicable to this part of the river, and the snag-boats and parties transferred to the Ocmulgee.

The work done is as follows: One hundred and ninety-nine snags and logs and four hundred and ten overhanging trees were removed; 245 cubic yards of log and brush jetties put in.

In the month of May the steam snag-boats were sent up the river, removing dangerous obstructions en route to Carr's Shoals, about 5 miles

above Dublin, to commence the work of clearing the channel at these shoals. At this point the channel will be improved by cutting through a rock reef and removing bowlders. In order to facilitate the work of excavating in the channel Assistant Engineer C. A. Locke, in local charge of the improvement of this river, with a force of thirteen men, was employed during the month of June in building a temporary dam of sheet piles above the rock reef. This temporary dam has been completed, and work of excavating will be begun at once.

The character of this stream is similar to that of the Ocmulgee River, and the improvement cannot be considered as strictly permanent, for an annual expenditure will be necessary to keep the improved channel clear of surface obstructions. The balance available and the appropriation herein asked for can be profitably expended in continuing work in the channel below the Central Railroad Bridge and finishing improvement of Carr's Shoals.

A new steamboat, William M. Wadley, has just been launched at Dublin. Size of hull, 22 by 105 feet; cylinders, 10 by 48 inches; with steel boilers.

A new steam tow-boat, 20 by 90 feet, with cylinders 12 by 48 inches, is being constructed at Dublin.

There are now four or five steamboats which ply on this and the Ocmulgee rivers. Their cargoes consist of cotton, provisions, lumber, rosin, and turpentine.

The steamboats *Ida*, *Halcyon*, *Cumberland*, and *Colville* have been running on the Oconee during the past year.

Capt. R. C. Henry, of the steamer *Colville*, has furnished the following statement of the quantities of freight transported by that boat on the Upper Oconee, above Dublin, during the year 1882:

Fertilizers	tons..	850
Cotton	bales..	3,000
Naval stores	barrels..	2,000

During the year ending March 1, 1883, the *Ida* alone transported 7,014 tons of freight, consisting of cotton, provisions, rosin, and turpentine. Messrs. B. Stansel & Co., manufacturers of naval stores, estimate that 3,500 barrels of turpentine and 19,315 barrels of rosin will be produced on the Oconee during the current year. Large quantities of lumber and hewn timber are transported annually. Statistics of the quantities for this river alone are not obtainable, but, according to information received from various sources, at least 110,000,000 feet, board measure, were sent down the Altamaha River during the year ending July 1, 1882, coming principally from the Ocmulgee and Oconee rivers.

Estimates for improving the Oconee River	\$50,000 00
Amount appropriated	20,500 00
Amount expended	18,271 19

Money statement.

July 1, 1882, amount available	\$37 85
Amount appropriated by act passed August 2, 1882	5,000 00
	<hr/> 5,037 85
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$2,088 31
July 1, 1883, outstanding liabilities	720 73
	<hr/> 2,809 04
July 1, 1883, amount available	2,228 81
	<hr/> 2,228 81
Amount (estimated) required for completion of existing project	29,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1885 ..	10,000 00

Y 13.

IMPROVEMENT OF RED RIVER, TENNESSEE.

This stream is a tributary of the Cumberland River, which it enters near Clarksville, Tenn. It was examined in December, 1880, for a distance of 38 miles, from Port Royal to its mouth.

An appropriation of \$5,000 was made in 1881 for its improvement, which was expended in 1881 in clearing the channel of snags, logs, &c., and in building riprap dams. Steamboats of light draught can go as high as Port Royal during four months of the year.

No work has been done during the fiscal year. No appropriation was made for this river by act of August 2, 1882.

The three bridges that cross this stream are without draws, and will of necessity greatly interfere with steamboats, and high-water navigation generally.

The appropriation estimated for could be applied to clearing the channel and building wing-dams as proposed by the existing project, though it does not appear that the improvements already made have been utilized.

Estimate of cost of improving Red River, Tennessee	\$10, 103 00
Amount appropriated	5, 000 00
Amount expended	4, 956 43

Money statement.

July 1, 1882, amount available	\$43 57
July 1, 1883, amount available	43 57
Amount (estimated) required for completion of existing project	5, 103 00
Amount that can be profitably expended in fiscal year ending June 30, 1885 ..	5, 100 00

Y 14.

IMPROVEMENT OF LITTLE TENNESSEE RIVER, TENNESSEE.

This river rises in the Blue Ridge, flows northwesterly, and empties into the Tennessee, near Lenoir's Station.

Examinations of this stream were made in 1874, 1875, and 1882.

The plan of improvement consists in removing snags, bowlders, reefs, &c., from a channel 40 feet wide, and in building wing-dams, where necessary, to confine the water, so as to afford 2 feet in depth from its mouth to the Jellico River, a distance of 13 miles.

Active operations were commenced in March by a small force of hired laborers, under the local charge of Assistant Engineer John S. Crary, and have been carried forward to the close of the fiscal year.

The progress of the work has been seriously retarded by frequent high water, so that the work has been principally confined to the improvement of Coytee Shoals; 13 cubic yards of solid rock and 97 cubic yards of bowlders were excavated from channel; 62 cubic yards of stone quarried; 156 cubic yards of riprap dam and 11 cubic yards of embankment built; five snags and one hundred and five overhanging trees removed.

The unexpended balance and the appropriation herein estimated for can be profitably expended in carrying forward the work according to the present plan.

No satisfactory commercial statistics have been received for this

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stream, but it is known that considerable quantities of grain and marble are shipped annually, commerce being chiefly carried on by small steamboats from the Tennessee River.

Estimate for improving the Little Tennessee River from its mouth to Jellico River (upon which the present plan is based)	\$23, 724 00
Amount appropriated	5, 000 00
Amount expended	2, 200 54

Money statement.

Amount appropriated by act passed August 2, 1882	\$5, 000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$1, 712 95
July 1, 1883, outstanding liabilities	487 59
	<hr/> 2, 200 54
July 1, 1883, amount available	<hr/> 2, 799 46
Amount (estimated) required for completion of existing project	18, 724 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	10, 000 00

Y 15.

IMPROVEMENT OF SOUTH FORK OF CUMBERLAND RIVER, KENTUCKY.

This stream rises in Tennessee, and is known as New River from its source to the mouth of Clear Fork, flows north, and empties into the Cumberland River at Point Burnside. Above the "Devil's Jumps" the South Fork lies in a rocky cañon, and large numbers of immense boulders, containing from 400 to 8,000 cubic yards each, are scattered throughout its bed, effectually preventing its navigation, and rendering its improvement impossible, save at enormous cost. From Devil's Jumps to Dick's Jumps (12½ miles) the characteristics change to those of a wild mountain stream; and from Dick's Jumps to the mouth (31 miles) the obstructions are similar to other mountain streams.

The State never improved this river, but some years since, I am informed, granted a charter to a private company for that purpose.

The plan of improvement is based upon the examination made in 1881, and provides for removing the boulders, excavating a channel through the rock and gravel bars, and building riprap dams, so as to provide for down-stream navigation when there is a tide of at least 3 feet above low water.

Assistant Engineer W. C. Crozer, in local charge of this work, commenced active operation in March with a small force of laborers that had just completed work at Smith's Shoals. During the month the river rose to an unusual height for the season of the year and so continued, preventing work being done to advantage, and the work was suspended in April to await more favorable conditions. But little useful work was therefore accomplished.

At Sloan's Shoals a brush-dam was built on the right bank, and brush cut and placed over the entire bar to protect it and cause it to fill up, and thus contract the water-way, and retard the current above the shoals; fifty overhanging trees were cut, and 60 cubic yards of stone quarried for dams. At Mercer Shoals one large snag and 3 cubic yards of loose rock were removed from the channel.

The balance available and the additional appropriation asked for can

be applied to carrying forward the present plan of improvements from the mouth of the river to the Kentucky State line. Most of the projected work will be comparatively permanent.

The present commerce of the river is principally in saw-logs, of which 5,000 were brought down the past season. Abundance of fine coal outcrops on this river, and large shipments of it will probably be made on the completion of this improvement.

The legislature of Tennessee at its last session enacted that—

Whereas the Big South Fork of the Cumberland River is now declared to be a navigable stream; and

Whereas said river changes its name above the mouth of Clear Fork and takes the name of New River: Therefore,

That New River be declared a navigable stream for all purposes.

The original estimate of cost of improving South Fork of the Cumberland River in Kentucky was.....	\$62,803 00
Amount appropriated	3,000 00
Amount expended.....	1,696 32

Money statement.

Amount appropriated by act passed August 2, 1882.....	\$3,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$1,636 32
July 1, 1883, outstanding liabilities	60 00
	<hr/> 1,696 32
July 1, 1883, amount available.....	<hr/> 1,303 68
Amount (estimated) required for completion of existing project.....	59,803 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	10,000 00

APPENDIX Z.

IMPROVEMENT OF THE OHIO RIVER AND OF THE FALLS OF THE OHIO; OPERATING AND MAINTAINING THE LOUISVILLE AND PORTLAND CANAL; IMPROVEMENT OF MONONGAHELA RIVER, WEST VIRGINIA AND PENNSYLVANIA, AND OF ALLEGHENY RIVER, PENNSYLVANIA; CONSTRUCTION OF ICE HARBOR AT MOUTH OF MUSKINGUM RIVER, OHIO, AND OF A HARBOR OF REFUGE NEAR CINCINNATI, OHIO.

REPORT OF LIEUTENANT-COLONEL WILLIAM E. MERRILL, CORPS OF ENGINEERS, BVT. COL., U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. Ohio River. 2. Operating and maintaining the Louisville and Portland Canal. 3. Monongahela River, West Virginia and Pennsylvania. | <ol style="list-style-type: none"> 4. Allegheny River, Pennsylvania. 5. Ice harbor at mouth of Muskingum River, Ohio. 6. Harbor of refuge near Cincinnati, Ohio. |
|--|---|

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, August 16, 1883.

GENERAL: I have the honor to submit herewith the annual reports on the works under my charge for the fiscal year ending June 30, 1883.

Respectfully, your obedient servant,

WM. E. MERRILL,
Lieutenant-Colonel of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

Z 1.

IMPROVEMENT OF THE OHIO RIVER.

At the opening of the fiscal year, July 1, 1882, the following contracts were outstanding:

Date.	Locality.	Miles from Pittsburgh.	Work.	Contractor.
1882.				
May 8	Davis Island Dam ...	5½	Iron work of weirs ...	Pittsburgh Bridge Company.
May 20	.....do.....	5½	Coffer-dam timber ...	John Wesley Cook.
May 31	.....do.....	5½	Wicket timber ...	W. H. Sherwood & Co.
May 31	.....do.....	5½	Foundation timber ...	Sewickley Oak Lumber Company.
May 31do.....	5½	Lock-gate timber ...	Walter and Darragh.
June 3do.....	5½	Guide-crib timber ...	Harmon B. Nease.

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Date.	Locality.	Miles from Pittsburgh.	Work.	Contractor.
1881.				
June 25	Brown's Island	63	Dam	N. W. Tucker.
June 29	Twelve Pole Bar	312	Dike	Clendinen & Graham.
Aug. 5	Portland Bar	603	...do	W. A. Hicka.
June 24	Puppy Creek Bar	743	...do	Jacob Clark.
1879.				
July 12	Head of Grand Chain ..	944	...do	C. M. Cole.
Oct. 25	Foot of Grand Chain ..	947	...do	C. M. Cole.

The following contracts were made during the fiscal year :

On August 15, 1882, a contract was made with F. O. Norton, of New York City, to furnish 15,000 barrels, more or less, of cement for the Davis Island Dam, at \$1.50 per barrel delivered at the work. His proposal was the only one received in answer to advertisement of May 23, 1882.

By advertisement dated September 11, 1882, proposals were invited for constructing an iron-dredge hull to replace the worn-out wooden hull of the dredge Oswego. The following bids were received and opened on October 5, 1882:

Proposals for iron-dredge hull.

No.	Bidders.	Amount.
1	Allen & Blaisdell	\$19,750
2	Boes & Thorn	23,000

Contract was awarded to Allen & Blaisdell, of South Saint Louis, Mo., and executed under date of October 11, 1882.

By advertisement dated January 8, 1883, proposals were invited for furnishing 10,865 feet of half-inch chain for the trestles and wickets of the Davis Island Dam.

The following bids were received, and were opened on February 16, 1883:

Proposals for chains for Davis Island Dam.

No.	Bidders.	Price.	Cost.	Remarks.
		<i>Per pound.</i>		
1	Miller Chain Company	\$0 05 1/2	\$1,312 50	
2	Wheeler Iron Company	08 1/2	1,625 00	
3	Bradlee & Co.	08 1/2	2,125 00	
4	J. W. Jones	08 1/2	2,125 00	
5	Oliver Brothers & Phillips	13 1/2	3,375 00	
6	D. Round & Co.			Informal
7	Alfred Box & Co.			Do.
8	Samuel G. Taylor			Do.
9	Relter & Co.			Do.

Contract awarded to the Miller Chain Company, and executed under date of February 25, 1883.

The contractors for furnishing the lock-gate timber for the Davis Island Dam, Messrs. Walter & Darragh, of Sharpsburg, Pa., having failed to comply with the provisions of their contract of May 31, 1882, this contract was annulled by authority of the Chief of Engineers (letter August 30, 1882), and proposals for furnishing this timber were again

invited by advertisement dated February 8, 1883. The following was the only bid received:

Proposals for lock-gate timber for Davis Island Dam.

Bidder.	Class of timber.	Price.	Cost.
W. H. Ewing	Timber for chords	<i>Per M.</i> \$59 75	\$1,215 87
Do	Braces and plank	44 75	2,122 76
Aggregate .....	.....		3,338 43

Contract for furnishing the above timber entered into March 24, 1883, with Mr. W. H. Ewing, of Pittsburgh, Pa.

By advertisement dated January 12, 1883, proposals were invited for furnishing the iron-work and wood-work for a section of movable dam 200 feet in length for the Middle Chute Falls of the Ohio. The following bids were received, and were opened on March 1, 1883 :

Proposals for iron-work and wood-work for movable dam, Falls of Ohio.

No.	Bidders.	Cost.
1	Queen City Bridge and Steam Forging Company	\$2,375 00
2	Ainslie, Cochran & Co.	2,400 00
3	Pittsburgh Bridge Company	2,480 77
4	The Sneed & Company Iron Works	2,561 00
5	Wilcox & Scaife	2,630 00
6	Allen & Blaisdell	2,785 00
7	H. A. Ramsay	2,950 00

Contract entered into March 12, 1883, with the Queen City Bridge and Steam Forging Company, of Cincinnati, Ohio.

By advertisement dated April 18, 1882, proposals were invited for constructing two 80-foot barges for use in connection with the improvement of the Falls of the Ohio. The following bids were received, and were opened on May 25, 1883 :

Proposals for two 80-foot barges.

No.	Bidders.	Cost.
1	John Wesley Cook	\$2,100
2	Howard & Co.	2,100
3	John Young	2,130
4	Covington Dock Company	2,295
5	J. K. Thayer	2,350

Contract awarded to John Wesley Cook, of Allegheny, Pa., and executed under date of June 11, 1883.

WORK DONE DURING THE YEAR.

The following is the record of the year's work:

Davis Island Dam, 5 miles below Pittsburgh.—The work at this place has been under the local charge of Capt. F. A. Mahan, Corps of Engineers, throughout the fiscal year. His report is as follows:

The most important part of the work is naturally the construction of the weirs. On August 7, 1882, the construction of the coffer-dam for this part was begun; its dimensions were 1,334 feet in length, 12 in breadth, and 10 in height. The amount of puddling was about 5,900 cubic yards. The coffer-dam was so far finished on August 21 that the pumps could be started. While building the coffer-dam two days and a half were lost by high water, consequently the actual building time until the pumps were started was eleven days and a half. The whole of the puddling, however, was

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not finished until about ten days later. The sand-pump used with such good effect during the season of 1881 was tried, but the results obtained by it were unsatisfactory. The main cause of this was the quantity of willow roots and branches in the puddling material. These, catching in the hollow arms of the pump and becoming jammed against the shell, caused the pump to stop at frequent intervals and twice broke it. The first time the break was mended, but the second time it would have been necessary to buy a new casing. Under the circumstances I considered this an unnecessary expense, and, therefore, I abandoned this method of work. When the puddling material is free from impurities the pump is undoubtedly an excellent affair, but under other circumstances the loss of time by delays more than counterbalances the economy of the pump's work. During 1882 the puddling was put in almost entirely with wheelbarrows. The total cost of putting in the puddling, as given by the construction book, is:

For wheelbarrow work in August.....	\$996 24
For wheelbarrow work in September.....	127 84
Total for wheelbarrow work.....	1,124 08
For work with sand-pump in August.....	431 83
For work with sand-pump in September.....	26 66
Total for work with sand-pump.....	458 49

but not including any purchase of machinery; in other words, for labor only.

The sum of these totals is \$1,582.57, and dividing this by 5,585 we find the cost of the puddling per cubic yard to be 28 cents. It was impossible to tell exactly what the sand-pump really did, its running was so irregular, and at times both it and the wheelbarrows were filling the same places. As nearly as can be estimated it put in 550 cubic yards. Dividing \$458.49 by 550 we have 83 cents as the cost of delivery per cubic yard. The work done by wheelbarrows was 5,035 cubic yards, at a cost of \$1,124.08, which is 22 cents per cubic yard. For short distances and ordinary material the wheelbarrow is much better than the sand-pump. For great distances and clean material I have no doubt of the superiority of the pump.

The excavation for the weirs was begun on August 21. At first this was rather slow work. Various methods were tried, but none were wholly satisfactory. Finally, on September 4, we started what is known in railway work as a *running dump*. This consists in having the vehicles running in a constant direction on an endless track. In this case the part of the track in the excavation was about 300 feet long, having at one end a straight inclined plane, leading out at right angles, and at the other end a circular incline. The connection between the track in the excavation and the straight incline was made by a turn-table. At the head of the straight incline was a second turn-table. When a car was filled it was placed on the turn-table at the foot of the straight incline, up which it was drawn, by means of an engine near the top, and landed on the upper turn-table, whence it was run out on the dump-track. After being emptied it was run out to the end of the dump-track, which was parallel to the excavation track, and went back to the excavation at the end opposite to the first turn-table. There it was connected with the train in the excavation by means of a long link. When the car at the head of the excavation was full it was hauled to the turn-table by an engine, and the whole train followed. By this means a car would come empty to the excavation, and as it passed along the track from one gang of men to another, additions would be made to its contents. By means of this running dump we were able to take out during the week ending September 9, the first week that it was working, an average of 507 cubic yards a day, and in the following week we made 552 yards a day.

On the 21st of September we began the concreting, which was carried on according to the system in use during past seasons. The rest of the work on the piers and in the superstructure of the dam offers nothing of special interest. Suffice it to say that the foundations of the weirs were completed, the wickets and their appurtenances were placed, and the trestles were fitted without their floors. The piers were finished as far as could be without the iron platforms belonging to them.

The fixed dam between Davis Island and the left bank of the river was begun during the latter part of October. An excavation was dug and in it was set a crib to protect the foot of the apron. Of the superstructure of the fixed dam about one-fourth is finished. The side cribs are about nine-tenths done. Some 600 cubic yards of riprap have been accumulated for use in the various parts of the structure. Between the side cribs and the solid earth a large amount of gravel has been placed. This filling is more than five-sixths done.

Near the abutment of the movable dam about 1,000 yards of filling was required to grade down the bank. Half of this is done.

Five hundred linear feet of the coping of the land wall of the lock has been put in place. This contains 140 cubic yards. The pier-head of the river wall has been begun, work having been done there during the last five days of the fiscal year. The lower guide crib for the lock has been built, and the sewer which carries off the water from the Bellevue ravine has been finished.

The following are some of the more important dates connected with the work:

August 7, coffer-dam begun.
 August 21, started to pump and began excavation.
 August 28, coffer-dam filled up on account of rise.
 August 30, coffer-dam pumped out after rise.
 September 4, began to use running dump.
 September 12, coffer-dam allowed to fill on account of rise.
 September 13, coffer-dam pumped out.
 September 16, began stone work of pier 1.
 September 20, lost a large number of men on account of mills starting up.
 September 21, concrete work begun.
 October 14, excavation for weirs finished.
 October 14, began laying timber foundations.
 October 21, concrete to bottom of timbers finished.
 October 24, began to sink tail crib of fixed dam.
 November 11, finished timber foundations.
 November 11, began masonry of abutment.
 November 18, finished concrete work.
 November 18, finished masonry of piers.
 November 25, all machinery, except derricks for abutment and pumps, removed.

The following is a summary of work done during the season:

- 1 coffer-dam built, 1,334 by 12 by 10 feet.
- 13, 688 cubic yards of excavation removed.
- 5, 947 cubic yards of concrete put in place.
- 1, 015 cubic yards of masonry laid.
 - 1 tail crib sunk for fixed dam, 486 by 12 by 8.5 feet.
 - 1 side crib for fixed dam, 228 by 15 feet by 22 inches, maximum height.
 - 1 side crib for fixed dam, 131 by 15 feet by 22 inches, maximum height.
- 573 cubic yards of riprap placed in tail crib.
- 1, 615 cubic yards of riprap placed in right-side crib.
- 530 cubic yards of riprap placed in left-side crib.
 - 1 guide wall (lower) at lock, 250 by 17 by 15 feet.
- 2, 375 cubic yards of riprap in lower guide wall.
- 900 cubic yards of riprap in upper guide wall.
- 140 cubic yards of land wall coping laid.
- 166 wickets with their appurtenances placed.
- 77 trestles placed.
- 27 wickets framed and put together for head of lock.
- 21 bents of fixed dam in position.
- 80 bents framed for fixed dam, and ready to be put together.

On February 4, 1883, the river began to rise very rapidly at 9 a. m., coming up nearly 3 feet in the first half hour. All day it kept steadily rising with great quantities of ice running. By the afternoon of the 5th, the ice had nearly disappeared. During the night of the 6th and 7th, the coffer-dam was almost wholly carried away. This was no loss, as we were through with it, and it saved the labor of taking it out. The value of the material lost was not equal to what it would have cost to dismantle the coffer-dam and remove it.

The progress of the work was much impeded by the utter failure of the timber contractors who were to have supplied the material for the foundations of the weirs and for the fixed dam.

Finally, on July 30, Mr. W. H. Ewing was authorized to furnish the foundation timber. This he did as rapidly as possible. The work was nevertheless much delayed and put to a great deal of extra cost, owing to loss of time.

On September 30, Mr. Ewing was notified to go ahead with the timber for the fixed dam. This he delivered as fast as he could; but it was not fast enough to allow the dam to be finished last season, which could easily have been done if the contract had not gone into the hands of incompetent persons.

Great delay was also caused by the lack of promptness on the part of the Pittsburgh Bridge Company, the contractors for the iron work for the weirs. They were about three months behind in furnishing their part of the work.

To estimate the loss to the work on the three contracts would be an exceedingly difficult matter. I do not hesitate to say, however, that it will not fall far short of \$15,000 or \$20,000.

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The following work remains now to be done:

1. Complete fixed dam and its side cribs.
2. Complete earth filling between side cribs and banks, including paving.
3. Complete service bridge, including piers and pier platform.
4. Complete earth filling about abutment of movable dam.
5. Put on the coping of the lock walls.
6. Build movable dam at the head of the lock and the lock gates.
7. Place valves in river wall and adjust those in the recesses.
8. Put in machinery for moving the gates and wickets, including tanks, reservoirs, pumps, boilers, &c.

The work on the fixed dam will require—

1. Preparation of the bed of the river:	
12 men for 24 days, at \$1.75	\$504 00
1 foreman 24 days, at \$2.50	60 00
2. Complete filling of tail crib:	
1,400 cubic yards of riprap, at \$1.50	2,100 00
3. Build remainder of dam:	
4 carpenters, 24 days, at \$3.50	336 00
12 laborers, 24 days, at \$1.75	504 00
2 teams, 24 days, at \$6	288 00
4. Finish side cribs:	
2 carpenters, 6 days for building, at \$3.50	42 00
4 laborers, 6 days for building, at \$1.75	42 00
10 laborers, 3 days to supply timber, at \$1.75	52 50
1 foreman, 3 days to supply timber, at \$2.50	7 50
350 cubic yards of riprap, at \$1.50	525 00
2,100 cubic yards of riprap, at \$1.50, for apron and protection of the bed of the river	3,150 00
Total for fixed dam	7,611 00

About one-half of the filling called for in my estimate of March 27 has been placed about the side cribs. To finish this work there will be needed—

1,000 cubic yards of gravel, at 60 cents	\$600
420 cubic yards of riprap for paving, at \$1.50	630
Labor in laying the paving, at \$1 per yard	420
Total for filling and paving	1,650

To finish the service bridge we need 76 cubic yards of masonry. This I estimated, on March 27, at \$10 per cubic yard. From a little piece of work which we tried the other day, the estimate is too small. It will cost at least \$15. It must be noticed that there is very little work at each place requiring a shift of everything at short intervals. Then, again, there is a great deal of fitting to do about the platforms.

The putting up of the iron work is something about which I can form no idea, as nothing of the kind has ever been done. I think, however, that \$3,000 will cover the cost. Hence we have—

76 cubic yards of masonry, at \$15	\$1,140
Putting iron work in place	3,000
Total for service bridge	4,140

In my last estimate the amount of filling to be placed about the abutment of the movable dam was 1,000 cubic yards. Of this amount, some 400 has been put in place, leaving 600 yet to be done. One hundred cubic yards of riprap for paving will also be required. Hence we have—

600 cubic yards of gravel, at 60 cents	\$360
100 cubic yards of paving, at \$2.50	250
Total for filling around abutment	610

For the coping of the lock walls:

910 cubic yards of masonry, at \$10	\$9,100
70 days of one stonecutter to make check for holding guard timber on land wall, at \$3.60	252
Total for coping	9,352

To build a coffer-dam at each end of the lock for putting in small movable dam at head of lock, building gates, clearing recesses, &c. :

220 linear feet, at \$22 \$4, 840

This is at the old price for labor, but wages have advanced at least 25 per cent., and we must therefore increase this estimate by that amount, making \$6,050.

The Chanoine dam at the head of the lock will cost—

110 linear feet, at \$20 \$2, 200

The lock gates are each 118 feet long, giving both a length of 236 feet.

The timber for these will cost \$3, 336 43

Framing, at \$12 per running foot..... 2, 832 00

Iron for gates:

52, 779 pounds wrought iron, at 10 cents..... 5, 277 90

61, 749 pounds cast iron, at 8 cents 4, 939 92

Total for gates 16, 386 25

The machinery for moving the gates, exclusive of motors, will require:

21, 435 pounds of cast iron, at 8 cents \$1, 714 80

9, 092 pounds of wrought iron, at 10 cents..... 909 20

Total for machinery of gates..... 2, 624 00

For the gate-sills the timber is now on hand. To lay them, including bolts, drift-bolts, spikes, &c., will cost about \$5 per running foot.

920 feet, at \$5 \$4, 600 00

4, 179 pounds of wrought iron, at 4½ cents 188 06

Total for the sills 4, 788 06

For the small gates to close main gate recesses there will be needed:

3, 500 feet, B. M., of oak, at \$34 per M..... 1, 190 00

Framing, putting together, and setting iron work, at \$15 per M..... 525 00

630 pounds cast iron, at 5 cents 31 50

3, 622 pounds wrought iron, at 8 cents..... 289 76

Total for recess gates..... 2, 036 26

Machinery for valves in the lock walls:

6, 036 pounds of cast iron, at 8 cents 482 88

2, 744 pounds of wrought iron, at 10 cents..... 274 40

Total machinery for valves 757 28

Water pipes and turbine platforms, 69, 013 pounds of cast iron, at 6 cents... 4, 140 78

Total for pipes..... 4, 140 78

Covers for machinery channels on lower walls of gate recesses and in the river wall, 13, 510 pounds of cast iron, at 4 cents..... 540 40

Total for plates 540 40

Three flushing-valves for lock and abutment:

338 pounds of cast iron, at 8 cents 27 04

3, 093 pounds of wrought iron, at 10 cents..... 309 30

Labor of stone-cutter and machinist adjusting valves to stone-work, at 1.5 cents per pound 51 47

Total for flushing-valves 387 81

Four-way and two-way cocks for water-pipes:

75 pounds of brass, at 40 cents..... 30 00

Labor cleaning gate-recesses, straightening bent valve-rods, adjusting valves, &c. This work is wholly indeterminate. It may amount to very little; it will probably be large, and may require the removal of some of the masonry. I shall allow for this:

Labor \$2, 500

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Masonry to complete gate-chambers:

158 cubic yards of concrete, at \$5	\$790
306 cubic yards of masonry, at \$10	3,060

Total masonry 3,850

Motive power, including turbines, pumps, tanks, reservoirs, boilers, pipes not mentioned above, &c., and labor on same, I shall put down for lack of detailed drawings and information at \$20,000.

As a scour may be looked for along the down-stream side of the movable dam, some allowance must be made for protection. The water is at present too high to make satisfactory investigation on this point. A row of piles driven 3 feet apart along a line parallel to and 50 feet down-stream from the dam will require 409 piles. I shall assume them to be 20 feet long and the scour to have an average depth of 5 feet.

409 piles, at 16 cents per linear foot	\$1,308
409 piles driven, at \$3	1,227
12,000 cubic yards of riprap	18,000

Total for protection 20,535

RECAPITULATION.

Fixed dam	\$7,611
Filling and paving near side cribs	1,650
Finishing service bridge	4,140
Filling and paving around abutment	610
Coping the lock walls	9,352
Coffer-dams in lock	6,050
Chanoine dam at head of lock	2,200
Building lock gates	16,386
Laying gate sills and tracks	4,788
Machinery to move gates, exclusive of motors	2,624
Small recess gates	2,036
Machinery to work valves	757
Water-pipes and turbine plates	4,140
Laying 870 feet of above pipes	217
Covers for machinery channels in walls	540
Flushing-valves	387
Four-way and two-way cocks	30
Cleaning gate recesses, &c	2,500
Masonry in gate chambers	3,850
Motive power, &c	20,000
Protection to dam	20,535

Total 110,406

Accompanying this report are two drawings showing the present condition of the work at Davis Island.

The financial condition of the work at the Davis Island Dam at the close of the fiscal year was as follows:

July 1, 1882, amount available	\$86,779 46	
Amount allotted from appropriation of August 2, 1882	165,000 00	
		\$251,779 46
July 1, 1883, expended during fiscal year	200,747 26	
July 1, 1883, outstanding liabilities	7,802 44	
		208,549 70
July 1, 1883, amount available	43,229 76	

Brown's Island, 63 miles below Pittsburgh.—Rebuilding of dam to close right-hand chute, under contract with N. W. Tucker, June 25, 1881. On the resumption of work during the last week in May, 1882, the dam was found to have been uninjured by the winter's ice and floods, and it was confidently expected that the contract would be completed before the close of the calendar year. The paving of the top surface of the dam was, however, delayed by high water during November and December, and at the suspension of operations in the latter month about 200 square yards of the paving remained unfinished.

Plate 1



During the winter of 1882-'83, owing, probably, to the unfinished condition of the paving, several hundred yards of stone were washed out of the crib-work, and the latter was also somewhat damaged by ice. These injuries will be repaired, and the contract will be finished during the present season.

Two hundred and eleven thousand and eighty-three feet, B. M., oak and hemlock timber, 14,291 pounds iron bolts and spikes, and 6,573 cubic yards riprap stone were expended on the work during the season.

Contract extended to August 1, 1883.

Twelve-Pole Bar, 312 miles below Pittsburgh.—Construction of dike under contract with Clendinen & Graham, dated June 29, 1881. Work was resumed by the contractors on July 22 and was suspended on December 26. The crib-work of the dike has been extended to its full length of 2,450 feet, and is complete with the exception of sixteen of the top cross-ties. There remains 200 feet of the crib-work at the lower end of the dike, which is not quite filled with stone, and the paving is unfinished on 350 feet of the top of the dike, and on 2,000 feet of the slope between the lower wall and the heel timber.

Owing to continued high water in the river the contractors were unable to finish the dike last season, and therefore requested an extension of time until August 31, 1883, which was granted.

One hundred and thirty-two thousand six hundred and eighteen feet, B. M., oak timber, 7,556 pounds of bolts and spikes, 4,505 cubic yards of riprap stone, and 20 cords of brush were put in the dike during the season.

Portland Bar, 603 miles below Pittsburgh.—Construction of dike, under contract with W. A. Hicks. Owing to the location of this dike at the foot of Falls of the Ohio, it is subject to be submerged by the slightest rise in the river, and on this account the working season is apt to be extremely short. Last year the river did not reach a suitable stage for work until the 11th of September, and the dike was again submerged on November 4. Between these dates the wood-work of the dike was extended 457 feet, making its total length 2,581 feet. The cribs are completely filled with stone, except for 100 feet at the lower end, which is about 6 inches below grade. The top surface has been paved for a length of 1,536 feet.

It has been determined not to extend this dike farther down-stream, and the work remaining to be done is, therefore, to place a bulkhead across the lower end, and to complete the ballasting and paving, all of which can be done in a few weeks of favorable water.

Twenty-eight thousand four hundred and fifty-one feet, B. M., square timber, 13,287 pounds iron bolts and spikes, and 5,921 cubic yards of riprap stone were used during the season.

Puppy Creek Bar, 743 miles below Pittsburgh.—Construction of dike, under contract with Jacob Clark, dated June 24, 1881. Work on this dike was resumed early in August, and was continued until December 15, when operations were suspended. The substructure, consisting of piles and brush weighted with stone, has been completed for the full length of the dike (2,850 feet), and the superstructure of oak timber, 4 feet in height, has been finished for 2,000 feet, with the exception of paving the top surface for 1,500 feet.

The time for completing the dike has been extended to December 31, 1883.

Eight hundred and eighty-one piles, 4,517.62 cords of brush, 18,198.60 cubic yards of riprap stone, 238,353 feet, B. M., oak and pine timber, and 19,641 pounds of bolts and spikes were used on the work during the season.

Grand Chain, 943 to 948 miles below Pittsburgh.—Construction of dikes at the head and foot of the chain, under contracts with C. H. Cole, dated July 12 and October 25, 1879, respectively.

Upper Dike.—The work of quarrying stone for the upper dike was resumed about the middle of May and was continued until the last of July, at which time a sufficient quantity to complete the dike (13,608 cubic yards) had been delivered on the bank near the work. The river, however, did not fall sufficiently to permit any work of construction until September 30. At the close of operations the last of November the substructure had been extended 400 feet, making its total length 2,100 feet. No addition was made to the length of the superstructure; this was, however, completed and paved for a distance of 1,670 feet from the shore end; 900 feet of the substructure and 1,330 feet of the superstructure are yet to be built. As the stone for completing this dike is all on hand, it is confidently expected that the work will be finished during the present calendar year.

Twelve thousand four hundred and eighty linear feet of round timber, 18,576 feet, B. M., square timber, 7,684 pounds of bolts and spikes, and 2,431 cubic yards of riprap stone were used on this dike during the season of 1882.

Lower Dike.—The construction of the lower dike was resumed early in October, as soon as its top surface appeared above the water, and was continued until December 16. A determined effort was made by the contractor to finish this dike during the year, but the working season proved too short; the substructure was, however, extended 460 feet, and completed to its full length of 3,130 feet, and the superstructure was completed and paved for 2,600 feet. There remains 530 feet superstructure yet to be completed.

Fourteen thousand five hundred and twenty-four linear feet of round timber, 61,816 feet, B. M., of square timber, 12,832 pounds of bolts and spikes, and 5,425 cubic yards of riprap stone, were expended during the season of 1882.

Contracts extended to December 31, 1883.

DEEDGING.

Work was begun by the dredges Ohio and Oswego on June 27, and operations for the season were suspended on November 16, at which date the dredges went into winter quarters at Marietta, Ohio. The following is a statement of the season's work:

Foot of Pike Island, 84 miles below Pittsburgh.—In November and December, 1879, the dredges removed the bar at Deep Run, on the Ohio side of the channel at Pike Island. Since that date this run bar had reformed, and again projected into the river so as to require removal by dredging.

Excavation made August 25–29, 5,301 cubic yards.

Upper Twin Island, 85 miles below Pittsburgh.—The work at this point consisted in the removal of the two run-bars on the Ohio shore, opposite the head of the island. These bars had for several years given much trouble to coal tows, by narrowing the channel and causing a cross-current toward the Virginia shore. Their removal widened the channel 150 feet, and straightened the current.

Excavation made July 25 to August 4, 42,461.7 cubic yards; one rock removed from channel weighing 4.7 tons.

Lower Twin Island, 86 miles below Pittsburgh.—One loose rock weighing 1.7 tons was removed from the channel at this place on August 24.

Wheeling Creek Bar, 90 miles below Pittsburgh.—This bar is formed of material washed into the river by Wheeling Creek, the greater portion being city refuse, dumped into the creek a short distance above its mouth. The effect of these deposits is to make the channel too narrow for coal tows, and to make navigation difficult by the creation of a cross-current toward the foot of Wheeling Island. Unless this practice is stopped frequent dredging will continue to be necessary.

The point of the bar was removed, the channel was widened 120 feet, and the cross-current was destroyed.

Excavation made June 27 to July 24, 13,535.3 cubic yards. A number of loose rocks were also taken out of the channel.

Fish Creek Island, 112½ miles below Pittsburgh.—The bar at this place is similar to those at the Twins and Pike Island, being a deposit from the creek on the Ohio shore. Owing to low water this work had to be abandoned after one cut had been made.

Excavation made August 30 to September 1, 2,620 cubic yards.

Newell's Run Bar, 157½ miles below Pittsburgh.—The improvement at this point consisted in the removal of the bar on the Ohio bank, caused by deposit from the creek which comes into the river at the head of the Second Brother Island. It resulted in widening the channel 120 feet, and in permitting the current to follow the Ohio shore.

Excavation made October 10–21, 16,214.7 cubic yards.

There were also removed from the channel at this place six logs weighing 8.4 tons, ten rocks weighing 30.1 tons.

Island Bar, Second Brother, 157½ miles below Pittsburgh.—A bar on the left of the channel, abreast of Second Brother Island, was removed by dredging. Two cuts were made, widening the channel 80 feet.

Excavation made October 23, November 4, 7,980 cubic yards.

Rowland's Race, 158 miles below Pittsburgh.—This place has long given trouble to boats and tows. It is at the foot of the Second Brother Island, and is a crooked shallow between two bars, forming the worst part of the 2 miles of bad river at the Three Brothers Islands. Two cuts were made on each side of the channel, which resulted in widening the latter by 125 feet, and in materially straightening the current.

Excavation made September 4, October 10, 18,934.2 cubic yards.

Little Muskingum Bar, 167 miles below Pittsburgh.—November 17, one snag removed, 2.5 tons.

Marietta, Ohio, 171 miles below Pittsburgh.—Most of the dredging at this point was in connection with the construction of Ice Harbor Lock, and consisted in furnishing material to fill and back up the coffer-dam. For this purpose the dredge Oswego was employed and made excavation September 15, October 18, 5,544.5 cubic yards.

From November 10 to November 16 the dredges were employed below the railroad bridge across the Muskingum in removing wrecks and snags, and in excavating from the channel. Excavation made, 4,327.7 cubic yards; snags removed, 2—weight, 2.5 tons; wrecks removed, 3 barges and 1 piece of crib dam.

The accompanying tables show the amount and cost of all dredging, wrecking, &c., for the season of 1882.

DREDGES IN COMMISSION, 1882.

Time at work:	Days.
Dredging gravel, &c	82
Wrecking, snagging, &c	7
Muskingum ice harbor	14
Total	103
Total on Ohio River	89

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Time lost:	Days
Traveling.....	3
Accidents.....	5
High and low water.....	7
Sundays.....	20
	<hr/> 35

Total.....	124
Total on Ohio River.....	122

Work:

Gravel, &c., excavated per day of work.....	cubic yards..	1,350.9
Gravel, &c., excavated during season.....	do.....	110,774.6
Wrecks removed.....	number..	4
Snags removed.....	do.....	9
Snags removed.....	tons weight..	14.4
Rocks removed.....	number..	14
Rocks removed.....	tons weight..	51.9

Cost—equipment:

Per day in commission.....	\$4 32
Per day of work.....	5 93
For the season.....	527 06

Towing:

Per day in commission.....	40 41
Per day of work.....	55 29
For the season.....	4,930 81

Salaries:

Per day in commission.....	39 69
Per day of work.....	54 40
For the season.....	4,841 83

Repairs:

Per day in commission.....	5 39
Per day of work.....	7 39
For the season.....	657 95

Total:

Per day in commission.....	89 81
Per day of work.....	123 01
For the season.....	10,958 25

DREDGES OUT OF COMMISSION, 1882.

Time:	Days
In ordinary.....	187
Annual spring repairs.....	40
	<hr/> 227

Cost:

Salaries in ordinary.....	\$1,823 00
Salaries during annual spring repairs.....	\$1,638 97
Annual spring repairs.....	2,267 48
	<hr/> 3,906 45
Total.....	<hr/> 5,729 45

Per day out of commission.....	25 24
Per day in ordinary.....	9 75

COST OF WORK, INCLUDING ALL EXPENDITURES DURING THE YEAR.

Dredging.....	\$15,375 18
Wrecking, snagging, removing rocks, &c.....	1,312 52
	<hr/> 16,687 70

Cost, per unit:

Per cubic yard of excavation.....	14
Per day in commission.....	136 78
Per day of work.....	187 50

1882.	Miles from Pittsburgh.	Place.	Kind of work.	Excavation.			Snags.		Expenditures.		Total.
				Gravel, &c.	Per day of work.	Cost.	Removed.	Weight.	For dredging.	For removing wrecks, snags, &c.	
				Cubic yards.	Cts. per day.	Cts. per cu. yd.		Tons.			
June, July	904	Wheeling Creek Bar	Dredging	13,585.3	1,128.0	\$0 18.8			\$2,250 03		\$2,250 03
July		do.	Removing rocks	42,461.7	1,486.9	12.5			3,343 81	\$46 88	5,343 81
July, August	85	Upper Twin Island	Dredging							48 88	5,343 81
August		do.	Removing rocks							93 75	5,343 81
August	84	Lower Twin Island	do.	5,301.0	1,514.6	12.0			656 26		5,343 81
August	1124	Foot of Pike Island	Dredging	2,026.0	1,016.0	18.5			375 00		5,343 81
August, September	1884	Fish Creek Island	do.	18,934.2	1,113.8	16.8			3,187 54		5,343 81
September, October	1884	Rowland's Race	do.							281 25	5,343 81
October	1884	do.	Removing rocks								5,343 81
October	1884	Newell's Run Bar	Dredging	16,214.7	1,621.5	11.5			1,875 02		5,343 81
October	1874	do.	Removing rocks and snags				6	8.4		187 50	5,343 81
November	1874	Second Brother Island	do.	7,980.0	1,985.0	9.4			750 01		5,343 81
November	171	Marietta, Ohio	do.	4,327.7	886.5				937 51		5,343 81
November		do.	Wrecking and snagging				4	3.5		562 51	5,343 81
November	167	Little Muskingum Bar	Snagging							93 75	5,343 81
							1	2.5			5,343 81
							9	14.4	15,875 18	1,312 52	16,687 70

The new iron hull for the dredge Oswego was completed and delivered at Cincinnati on March 16, 1883, by Messrs. Allen & Blaisdell, of South Saint Louis, Mo., in accordance with the terms of their contract of October 14, 1882. It is proposed to transfer the machinery of the old *Oswego* to the new hull before dredging operations are again resumed.

As a matter of interest in connection with the services of the Ohio River dredges, the following report of Mr. E. J. Carpenter, superintendent of dredging, upon a single day's performance of the iron dredge Ohio is herewith respectfully submitted:

It was considered desirable to ascertain the maximum amount of excavation that could be made by one of the Ohio River dredges, working under favorable circumstances. These conditions occurred at Newell's Run Bar on October 19, 1882, and the dredge Ohio was accordingly run to its full capacity for ten hours. In this time twenty-two scows were loaded and sent away, carrying an aggregate of 1,900 cubic yards of material. During the loading of six of the scows an account was kept of the exact time spent in the various operations of digging, changing scows, and moving the dredge; and also of the number of dipperfuls and the number of cubic yards of material placed in each scow. From these data the first of the following tables has been constructed.

The bar removed consisted of a mixture of gravel, mud, and stone, which had been washed into the river by Newell's Run. It had never been dredged before and was very compact, but the material was, on the whole, of a character favorable to rapid work.

It is not often possible to run a dredge for a whole day at the speed shown in this table, nor is it desirable to do so, because it greatly increases the probability of accident to the machinery, and the engineer and dipper-tender cannot stand the strain of continued work at this rate.

The Ohio River dredging fleet consists of two dredges, four scows, and a flat-boat, owned by the United States. A tow-boat of suitable power (with engines about 13" by 5') is chartered as a tender during the working season.

Delays and interruptions, while at work, are necessarily of frequent occurrence. Ordinarily the dredge tender is able to take away and dump the scows as fast as they are loaded, but at many places scant water, preventing scows from being loaded to their full capacity, long distance to the dumping-ground, occupation of the channel by passing boats and tows, insufficient room to handle the dredges themselves, &c., seriously reduce the amount of work that can be accomplished.

The material to be excavated may be of such character as to prevent rapid work, in which case the frequency of accidents to the machinery is much increased.

Under reasonably favorable conditions a dredge can excavate 1,200 cubic yards per day for a number of days without extraordinary risk to machinery, and without requiring undue exertion on the part of the crew.

The second of the tables below, which is based on the notes of the past season's work, is presented as showing the amount of excavation that has been made by a single dipper-dredge during periods of from four to sixteen consecutive working days.

For information as to the rate of excavation that has been maintained during the whole working season, attention is called to the regular tabular statement for the year.

In this connection a short description of the *Ohio* may be of interest.

The dipper-dredge Ohio is an iron boat, built in 1880. Her hull is 92 feet long, 31 feet 6 inches wide, and has 6 feet 2 inches depth of hold.

When trimmed for travel the dredge carries 800 bushels of coal, and draws 30 inches of water.

The crane was built in 1876 for the old wooden dredge Ohio. It is constructed of iron and steel, and weighs, without its rigging, 7 tons. It swings through an angle of 160 degrees, and has sufficient reach to deposit material 35 feet from center.

The hoisting machinery was originally of the Osgood pattern, with positive clutches, and was built in 1871, for the wooden dredge Ohio, by the American Dredging Company of Philadelphia. In 1881 it was remodeled, and supplied with the Alger friction-clutches, which had been used with great success on the dredge Oswego. These clutches, as now built for the Ohio River dredges, are constructed almost entirely of steel castings, which give great additional strength, and renders them much less liable to accident than were the old positive clutches. The use of friction-clutches has increased the capacity of the dredge full 30 per cent.

The main engines have two cylinders of 10 inches diameter and 15 inches stroke.

In the forward hold the dredge has a pair of 6 by 12 engines, geared together, which hoist all the spuds and operate the two capstans by which the dredge and scows are handled.

Steam is supplied by a return tubular marine boiler, which is 56 inches in diameter, 7 feet 6 inches high (exclusive of steam dome), and 8 feet 9 inches long. It has one hundred and sixteen return tubes $2\frac{1}{2}$ inches in diameter, and is worked at a pressure of about 85 pounds. For ordinary dredging it consumes 30 bushels of coal in ten hours.

Steel is used in place of iron for all cast parts of the machinery that are subject to great wear or sudden strains. Its use has given complete immunity from a very annoying class of accidents that was formerly of frequent occurrence.

Ordinary repairs are made by the dredge crew, for which purpose an outfit of carpenter's, blacksmith's and machinist's tools, with forge, drill-press, lathe, &c., is carried on the dredge.

In making up the crew care is taken to secure men who are good mechanics, as the boats are frequently at work on parts of the river where they are 50 miles or more from a machine-shop, and are thus obliged to depend on their own crews for repairs.

Duplicates of such parts of the machinery as experience has shown to be most liable to accident are kept on hand, fitted ready for use. Frequent accidents are unavoidable on dredges, as is proved by universal experience, but this provision saves valuable time that would otherwise be lost while waiting for repairs.

The dredge crew consists of seven men: one engineer, one dipper-tender, one fireman, one steward, and three deck-hands. The crew have their quarters and mess aboard the dredge.

The scows are 70 feet long, 20 feet wide, and have 5 feet 9 inches depth of hold. They have side doors for dumping, and carry, when level full, 93 cubic yards. Their draught of water, empty, is 20 inches, and when loaded between 5 and 6 feet.

The flat-boat is 80 feet long, 16 feet wide, and 4 feet 6 inches deep. It is used to carry supplies and spare machinery, spuds, &c., which are too heavy and bulky to keep on the dredges.

Table showing the amount and rate of excavation made by the United States dredge Ohio, at Newell's Run Bar, October 19, 1882.

Scow-load.	Dipperfuls in scow.	Cubic yards in scow.	Cubic yards per dipperful.	Time consumed, minutes.				Dipperfuls per minute.
				Digging.	Changing scows, &c.	Moving dredge.	Total per scow.	
No. 15.....	40	87	2.18	18½	4½	2	25	2.19
No. 16.....	39	88	2.23	19	7	.....	26	2.05
No. 17.....	40	84	2.10	21	7	3	31	1.90
No. 18.....	41	86	2.10	19½	5½	.....	25	2.12
No. 19.....	39	85	2.18	19	5	5	29	2.05
No. 20.....	41	87	2.12	21	6	.....	27	1.95
Average.....	40	86.2	2.16	19½	5½	1½	27	2.12

The dredge had to change its place each time that the scows were filled. The capacity of the dipper, when level full, is 2 cubic yards. During ten hours twenty-two scows were loaded, carrying an aggregate of 1,900 cubic yards. The measurements of material were made after it had been loaded into the scows.

Table showing some of the best work done by the United States dredges on the Ohio River during 1882.

Place.	Material.	Date, 1882.	No. of days.	Excavation.	
				Total.	Average per day.
Dredge Ohio:				Cub. yds.	Cub. yds.
Wheeling Creek Bar.....	Gravel, stones, &c.....	July 17-22.....	6	6,841	1,140
Twin Islands.....	Hard gravel.....	July 26-29.....	4	4,835	1,209
Do.....	do.....	August 14-19.....	6	5,778	962
Rowland's Race.....	do.....	September 4-9.....	6	5,761	960
Newell's Run.....	Gravel, mud, &c.....	October 3-21.....	16	18,371	1,148
Dredge Oswego:					
Twin Islands.....	Hard gravel.....	July 31-August 12.....	12	11,958	996
Rowland's Race.....	do.....	September 11-14.....	4	3,688	922

SNAG-BOAT E. A. WOODRUFF.

The snag-boat E. A. Woodruff, under command of Capt. H. W. Christian, began work in August 7, have been delayed since June 30 by the accidental explosion of her auxiliary boiler on the latter date, the boat being just ready to start with a full crew on board. This accident occurred during the preparation for a formal inspection of the boiler by the local inspectors of steam vessels, and was due to the fact that the carpenter misunderstood the orders of the second engineer, and braced down the safety valve of the auxiliary boiler while it was under steam. These facts were fully set forth in the official report of the local inspectors, who, at the request of this office, made a thorough investigation as to the causes of the explosion.

The boat worked over the river as follows: Cincinnati to Pittsburgh, 467 miles; Pittsburgh to Cincinnati, 467 miles; Cincinnati to head of Carpenter's Bar, 301 miles; head of Carpenter's Bar to Cairo, 800 miles; Cairo to Marietta, 795 miles; Marietta to winter quarters in Kentucky River, 370 miles, arriving at the last-named place on December 8. The total distance traveled during the season, including several minor trips made while passing over the river on the general routes above named, was 3,314 miles.

Nine hundred and ninety-six snags were removed during the season; forty wrecks were either wholly or partly broken up, and the remains of seven wrecks, previously partly destroyed, were wholly removed; ten leaning trees were felled and cut up, and six rocks, aggregating 42 cubic yards, were removed from the channel and landings.

Among the obstructions removed may be mentioned a portion of the State dam at the mouth of the Muskingum, which had been carried into the Ohio River by a flood in the Muskingum; the wreck of a model barge opposite Elliott's Landing, about 6 miles below Portsmouth, Ohio; the wreck of the steamer Vint Shinkle from the channel just below Owensboro', Ky., and the bottom of a coal-float from Kineon's Coal Landing, Cincinnati.

The six largest snags were two sycamore trees taken from the channel about 4 miles above Evansville, Ind.; one measuring 5 feet 8 inches in diameter at the butt and weighing 105½ tons, and the other measuring 5 feet 2 inches in diameter at the butt and weighing 100 tons; a sycamore tree from the channel at Walnut Bend, measuring 5 feet in diameter at the butt and weighing 102.4 tons; a sycamore tree off Bedford's Point, measuring 7 feet 8 inches in diameter at the butt and weighing 363½ tons; a cottonwood tree at the head of Stewart's Island, 3 feet 6 inches in diameter at the butt and weighing 243½ tons; and a sycamore tree from the channel in front of New Liberty Upper Landing, which measured 6 feet at the butt and weighed 114 tons. The average weight of eighty of the largest snags removed was 92½ tons.

REMOVING ROCKS.

As the river remained unusually high during the season, but little opportunity was offered for the removal of rocks. A steamboat and a crane-boat with a crew of ten men were, however, employed from October 19 until November 18 in removing rocks from the tow-boat channel at the left of Mustapha Island. The work was not entirely completed, on account of high water and cold weather, but sufficient was

accomplished to effect a marked improvement. Quantity of rock removed, 817 tons.

Some of the projecting rocks near the upper dike at the Grand Chain were removed during the low water of 1881, and the job was completed last season by the removal of some 300 cubic yards additional.

IMPROVEMENT OF THE FALLS OF THE OHIO.

This work was under charge of Lieut. Col. G. Weitzel until July 31, 1882, of Maj. F. U. Farquhar until September 18, 1882, and of Lieut. Col. William E. Merrill until the close of the fiscal year.

The year just past was remarkable for the long continuance of navigable water. As the removal of rock from the Indiana or main chute can only be undertaken during extremely low stages, no work of this character was possible during the fiscal year.

It is a part of the approved project to narrow the opening at the head of the Indiana Chute by two short sections of movable dam, each 160 feet in length, so that during low stages the outlet through the dam may be reduced to a width of 280 feet, while preserving the full outlet of 600 feet for all stages during which the falls are navigable. The south section of movable dam is on hand, and is ready to go in as soon as a low stage in the river will permit. A vigorous effort was made to erect this section last autumn, but it proved a failure on account of high water. The breakwater and coffer-dam remain in place, and by contracting the outlet add materially to the difficulty of ascending the falls, but they cannot be removed until the section of movable dam is in place.

Lieutenant-Colonel Weitzel's estimate (contained in his special report of February 10, 1882 (Report of Chief of Engineers, 1882, pages 1880 *et seq.*), for the completion of the improvement of the falls proper was \$242,088. Since that date there has been allotted for "Indiana Chute," from the appropriation for the Ohio River \$35,000 leaving \$207,088 yet to be appropriated for the completion of the work indicated in his report.

In the estimates for the Ohio River I have inserted \$50,000 for the Falls of the Ohio as the amount that can be expended if the season is reasonably favorable. The character of the proposed work is such that it can only be carried on when the Ohio is quite low, and, as such stages are of uncertain date and duration, it is necessary to have a fund in hand so as to utilize a favorable season whenever it happens to come.

In this connection I would request that the wording of appropriations for this work be made to read "Falls of the Ohio" instead of "Indiana Chute," as the latter is only a part of the falls, and it is equally necessary to improve the Middle Chute, the Varble Chute, and the dam across the head of the falls. Much embarrassment has been caused by the apparent restriction of work to the Indiana Chute. The object is to make the Falls of the Ohio more navigable, and the funds ought to be available where they will do most toward the attainment of this object.

The financial condition of the work is as follows:

July 1, 1882, amount available.....	\$37, 642 13	
Amount allotted from appropriation of August 2, 1882.....	35, 000 00	
		<hr/> \$72, 642 13
Expended during fiscal year.....	31, 973 53	
July 1, 1883, outstanding liabilities.....	2, 421 36	
		<hr/> 34, 394 89
July 1, 1883, amount available.....	38, 247 24	

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REPORT OF MR. P. J. SCHOPP, ASSISTANT ENGINEER.

LOUISVILLE, KY., July 1, 1883.

SIR: I have the honor to submit herewith the annual report on improving the Falls of the Ohio for the fiscal year ending June 30, 1883.

The working season of the year was not a favorable one, the stage of water being too high most of the time.

The deposit in the high-water channel under the draw of the railroad bridge, known as "Varble Chute," had accumulated during a number of years, interfering with the passage of boats. It was removed to the depth of 2 feet, and the channel was considerably improved.

In the season of 1881-'82 a breakwater had been constructed at the end of the falls dam, and at the head of the Indiana Chute, in order to serve as a protection to the coffer-dam, within which was to be erected 160 feet of movable dam of the Boulé type. It was not until October 30 that work could be continued by placing an earth coffer-dam inside of the breakwater and commencing to pump. On account of the rugged surface of the bed rock the attempt to make the dam water-tight proved successful only after frequent leaks had been stopped. At this stage the river unfortunately rose and overflowing the entire works, forced the suspension of the operations for the season.

The iron trestles intended for this dam were received, as also the timber for the foundation. The whole structure was temporarily erected at the canal shops, so as to make sure that it was complete.

It has been proven by experience that the 300-foot opening in the Middle Chute, which was intended for the use of ascending boats during high water, was not wide enough, and that the current through it was too strong. It was therefore decided to make the opening 200 feet wider, and to lengthen the movable dam to the same extent. The necessary timber and iron for the foundation have been purchased, and the iron trestles and gates for the same have been completed under contract of March 12, 1883, with the Queen City Bridge and Steam Forging Company of Cincinnati, Ohio.

A large amount of timber and iron has been purchased for the construction of guiding dikes at the Indiana and Middle chutes, which will assist navigation by making the currents less divergent.

On account of the continued high water the work of removing the rock obstructions in the Indiana Chute could not be resumed, and no rock was removed during the year.

The survey of the rock ledge south of the Middle Chute was continued, and, with the exception of a small space above the dam, it was completed as far down as the railroad bridge. The territory between the bridge and the foot of the falls and south of the line of the Middle Chute remains yet to be surveyed. The survey should be continued so as to complete the map of the falls, and give correct data for estimates of all intended improvements.

The records of vessels passing over the falls and not using the canal were prepared from reports kindly furnished to this office by Messrs. Pink Varble, John Littrell, and James T. Duffy, falls pilots.

The falls were navigable during the year two hundred and fifty-seven days for descending boats, and fifty-seven days for ascending boats. During the time the falls were navigable fourteen hundred and seventy-five vessels passed over, representing an undertonnage of 461,042 tons. Among the cargoes were 1,335,400 bushels of coal, 10,988 tons of iron ore, and 4,000 barrels of salt, proving the great importance to commerce of this channel.

Very respectfully, your obedient servant,

PHIL. J. SCHOPP,
Assistant Engineer.

Lieut. Col. WILLIAM E. MERRILL,
Corps of Engineers, U. S. A.

Detailed statement of vessels passed over the Falls of the Ohio during fiscal year ending June 30, 1883, with amount of coal, iron ore, and salt.

DESCENDING VESSELS.													
1882-'83.	Passenger boats.		Tow-boats.		Model barges.		Square barges.		Government boats.	Salt.	Coal.	Total.	
	No.	Under-tonnage.	No.	Under-tonnage.	No.	Under-tonnage.	No.	Capacity.				Vessels.	Under-tonnage.
								Tons.		Bbls.	Bushels.		
July.....	30	10,025	10				11	1,127				51	11,898
August.....	33	8,483	11		3	868	10	1,356				57	11,190
September....	8	2,292	5				1	94				14	2,671
October.....													
November.....													
December.....			1	300			20	2,640				21	2,940
January.....	8	4,060	3	355			19	4,662			267,000	28	9,077
February.....	21	9,315	60	10,234	11	3,513	361	127,640			6,587,000	453	150,092
March.....	31	15,364	18	1,089	9	3,010	21	4,558			130,000	74	24,021
April.....	39	20,304	72	11,835	23	9,882	335	118,766	81	4,000	6,370,000	505	160,817
May.....	22	10,003	4	607			4	376	13			43	10,988
June.....	26	11,720	8	556			13	1,078	1			48	13,954
Totals....	218	91,566	187	26,504	51	17,273	795	262,897	45	4,000	13,354,000	1,294	398,240

ASCENDING VESSELS.											
1882-'83.	Passenger boats.		Tow-boats.		Model barges.		Square barges.		Iron ore.	Total.	
	No.	Under-tonnage.	No.	Under-tonnage.	No.	Under-tonnage.	No.	Capacity.		Vessels.	Under-tonnage.
								Tons.	Tons.		
July.....											
August.....											
September....											
October.....											
November.....											
December.....											
January.....			1	436						1	436
February.....	10	5,687	23	3,856	8	2,752			3,088	41	12,296
March.....											
April.....	25	13,701	28	6,264	14	5,250	67	22,152	7,900	134	47,867
May.....	3	1,704								8	1,704
June.....											
Totals....	38	21,092	52	10,556	22	8,002	67	22,152	10,988	179	61,802

1530 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

COMMERCE OF THE OHIO RIVER.

No complete records of the commerce of the Ohio are available. The following statistics of the river trade at Pittsburgh, Cincinnati, and Louisville, which it is believed will fairly indicate its extent and importance, are, however, respectfully presented as the best that can be procured.

Coal shipments from Pittsburgh by Ohio River during the fiscal year ending June 30, 1883.

[Prepared by Capt. W. Evans.]

1882-'83.	To Ironton.			To Cincinnati.					To Louisville.				
	Trips.	Barges.	Bushels (coke).	Trips.	Coal-boats.	Coal-barges.	Fuel-drafts.	Bushels.	Trips.	Coal-boats.	Coal-barges.	Fuel-drafts.	Bushels.
July				4		37	2	444,000	7	12	66	5	1,870,000
August				27	3	251	14	3,464,000	6		60	10	1,520,000
September				25	9	277	8	3,682,000	12	9	115	2	1,552,000
October													
November				25		223	19	2,881,000	11	2	106	4	1,563,000
December				27	11	223	9	3,006,000	41	186	253	8	7,184,000
January				9	5	113		1,381,000	39	138	120	17	5,080,000
February				28		299	14	3,644,000	14		164	3	1,946,000
March				44	20	474	21	6,333,000	89	449	430	54	16,243,000
April				18	4	185	6	2,306,000	39	89	398	20	6,397,000
May				30	4	366	4	4,392,000	30	47	221	23	2,956,000
June													
Total	3	12	300,000	237	65	2,448	97	31,532,000	238	933	1,943	154	47,397,000

Grand total 79,230,000

During the year just past one tow-boat, the Harry Brown, carried to Cincinnati in one tow 324,730 bushels of coal, the largest single shipment ever made between these two points.

It is customary to double tows below Louisville, and the following amounts were carried from Louisville to New Orleans in one trip during the year by the tow-boats named:

	Bushels.
W. W. O'Neil	654,000
John A. Wood	677,000
J. B. Williams	700,000

Col. Sidney D. Maxwell, superintendent of the Cincinnati Chamber of Commerce, in his last annual report gives a full exhibit of the river commerce of Cincinnati, from which the following table, showing the principal items, has been compiled:

River commerce of Cincinnati for year ending August 31, 1892.

Articles.	To New Orleans.	To other down-river ports.	To up-river ports.	Total.
Ale, beer, and porter	1,181	1,716	14,046	16,943
Apples, green	1,124	13,506	1,007	15,637
Barley	140	5,066	4,230	9,436
Boots and shoes	1,007	19,760	12,740	33,507
Butter	3,779	2,702	185	6,666
Cheese	694	3,379	9,250	13,323
Coffee	276	7,715	15,815	23,806
Corn	1,117	35,414	237,003	273,534

River commerce of Cincinnati for the year ending August 31, 1882—Continued.

Articles.	To New Orleans.	To other down-river ports.	To up-river ports.	Total.
Flour.....barrels..	2,357	19,839	70,375	92,571
Furniture.....packages..	20,429	14,823	37,812	81,564
Glassware.....do.....	16,149	35,349	7,504	59,002
Hardware.....do.....	2,917	38,387	33,755	75,059
Hay.....bales..	2,256	2,824	7,787	12,867
Hog product:				
Bacon.....pounds..	617,580	1,219,200	4,360,975	6,206,755
Bulk, loose.....do.....	14,882	23,580	680,405	727,867
Bulk, in boxes.....do.....	898,000	33,500	1,322,500	1,754,000
Hams.....do.....	1,075,180	315,860	693,620	2,084,660
Lard, in tierces.....do.....	315,800	431,944	823,716	1,571,460
Lard, in kegs.....do.....	32,064	11,537	47,582	91,133
Pork.....barrels..	4,851	589	1,509	6,949
Iron and steel.....tons..	1,951	6,049	873	8,873
Iron, pig.....do.....	71	1,165	4,480	5,716
Lead, white.....kegs..	1,497	11,330	19,061	31,888
Malt.....bushels..		37,877	13,873	51,250
Molasses.....barrels..	195	3,908	10,964	15,067
Nails.....kegs.....	53,112	142,045	1,268	190,420
Oats.....bushels..	460	8,499	36,272	45,231
Oil.....barrels..	3,228	7,846	4,897	15,971
Peanuts.....bags..	394	1,390	6,559	8,343
Petroleum.....barrels..	3,764	12,133	2,352	18,249
Potatoes.....bags and barrels..	2,059	9,344	13,511	24,914
Salt.....barrels..	1,104	76,324	2,699	80,027
Seed, clover, timothy, &c.....bags..	249	4,353	10,025	15,227
Soap.....boxes..	36,264	24,818	30,430	101,512
Starch.....do.....	26,255	5,835	13,456	45,546
Sugar.....barrels..	184	7,173	11,567	18,923
Tobacco, leaf.....hogsheads..	49	1,329	3,715	5,093
Tobacco, manufactured.....packages..	904	5,806	11,679	18,289
Wheat.....bushels..		11,071	61,480	72,551
Whisky.....barrels..	14,098	30,474	37,805	72,377
Wool.....bales..		394	1,620	2,024

Colonel Maxwell reports that the stage of the river was unusually favorable for commerce, the river being navigable throughout its entire length for a continuous period of ten months.

The following table will show the most important facts concerning the steamboat interests of Cincinnati during the four years ending August 31, 1882:

Items.	1878-'79.		1879-'80.		1880-'81.		1881-'82.	
	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.
Steamboats landing at Cincinnati..	227	61,782	234	62,044	306	58,153	214	73,733
Steamboats built at Cincinnati.....	13	6,533	10	3,851	7	1,169	8	1,399
Model barges built at Cincinnati.....	3	810	6	2,219	8	10,067	5	4,309

Ports of departure and destination.	Arrivals.		Departures.		Arrivals.		Departures.		Arrivals.		Departures.	
	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.
From New Orleans.....	85		103		86		68					
For New Orleans.....		97		116		90		79				
From Pittsburgh.....	163		153		164		169					
For Pittsburgh.....		163		153		164		164				
From Saint Louis.....	64		93		42		38					
For Saint Louis.....		75		94		48		46				
From other ports.....	2,413		2,785		2,346		2,461					
For other ports.....		2,396		2,780		2,331		2,451				
Totals.....	2,725	2,730	3,163	3,172	2,638	2,633	2,736	2,739				

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Schedule of rates on flour per barrel by rail and river from Cincinnati during the calendar year 1882.

How transported.	To Pittsburgh.	To Louisville.	To New Orleans.
By rail.....	\$0 30	\$0 20	\$0 05
By river.....	0 25	0 16	0 65

Additional statistics as to Ohio River commerce can be found in the annual report on the Louisville and Portland Canal, to which reference is made.

WORK DURING 1883-'84.

As Congress at its last session failed to pass a river and harbor bill, work during the present fiscal year will be confined to the completion of the outstanding contracts reported above, and to such work on the Davis Island Dam as can be completed with the small balance on hand.

ESTIMATE FOR 1884-'85

As no action was taken on the estimates submitted with my last annual report, I renew them. The estimate for the completion of the Davis Island Dam is given in detail in Captain Mahan's report. I have asked for the amount of his estimate, less the amount now available for this work. The excess over the estimate of last year is due to the extra cost of keeping up the works for another year, the loss by exposure of unfinished work, the extra cost sustained during the past season by failures of contractors, and the fact that last year's experience has shown the necessity of adding a protection against scour below the dam that had not previously been thought necessary. The estimate is as follows :

Miles from Pittsburgh	Proposed works.	Estimated cost.
5	Davis Island Dam, completion.....	\$70,000
10	Merriman, new dike.....	22,000
53	Black's Island, repair of old dam.....	28,800
84	Twin Island repair of old dam.....	35,000
89	Wheeling Island, new dam.....	13,750
107	Captina Island, repair of old dam.....	18,000
112	Fish Creek Island, repair of old dam.....	22,300
157	Three Brothers, repair of old dam.....	15,000
219	Sand Creek, new dike.....	18,000
256	Eight-Mile Island, new dike.....	22,500
362	Bonanza (Cub Creek) Bar, new dike.....	33,000
451	Eight-Mile, new dike.....	33,000
485	Medoc, new dike and removal of old dike.....	30,000
501	Rising Sun, longitudinal shore-dike.....	60,000
508	Gunpowder, new dike.....	37,000
553	Madison Harbor, new dike.....	72,000
600	Falls of the Ohio.....	50,000
682	Flint Island, new dike.....	84,000
683	Oil Creek, new dike.....	72,000
764	Scuffletown, new dike.....	72,000
860	Caseyville, new dike.....	84,000
870	Walker's Bar, new dike.....	96,000
....	Snagging.....	25,000
....	Dredging.....	16,500
....	Completion of new iron dredge.....	4,000
....	Removing rocks.....	5,000
....	Office expenses, inspection, engineering, and contingencies.....	25,000
	Total	1,063,750

Before closing this report I would call the attention of the Department to the necessity of making some permanent provision for the running expenses of the Davis Island Lock and Dam when completed. These expenses could readily be raised from tolls so small that the river commerce would not feel them; but as Congress has positively forbidden the collection of any tolls at Government locks, some other provision must be made for operating expenses. I would therefore recommend that the same provision be made for this work as has been made for the Louisville and Portland Canal, the Des Moines Rapids Canal, and the Saint Mary's Canal.

Money statement.

July 1, 1882, amount available.....	\$158,575 44
Amount appropriated by act passed August 2, 1882.....	350,000 00
	508,575 44
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$362,913 69
July 1, 1883, outstanding liabilities.....	34,448 38
	397,362 07
July 1, 1883, amount available.....	111,213 37
Amount that can be profitably expended in fiscal year ending June 30, 1885.	1,063,750 00

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OPERATING AND MAINTAINING THE LOUISVILLE AND PORTLAND CANAL.

This work was under charge of Lieut. Col. G. Weitzel until July 31; of Maj. F. U. Farquhar until September 18; and of Lieut. Col. William E. Merrill until the close of the fiscal year.

During the year just closed the duration of navigable water was above the average, the canal having been closed by high water during fifty-seven days, while the average closure is forty-five days. In February occurred the greatest flood ever known in the Ohio Valley below Cincinnati, the stand at the locks being a little more than 3 feet above the highest water hitherto known—that of 1832. The masonry of the locks was not damaged, but a breach was made in the canal bank at the head of the old locks, fences were destroyed, lumber was washed away, and considerable minor damage was done.

During the year another portion of the guiding-dike at the head of the canal has been raised to the 12-foot stage, making a total length of 660 feet of raised dike. Just above the high part of the dike is a gap 100 feet wide for the passage of ice and drift. During low water this gap is closed by a movable dam of Thénard shutters. In April last a coal tow ran into this gap and destroyed some of the wickets. It is proposed to move the line of wickets to a point about 100 feet from the channel, where the object to be attained will be equally well served, and where there will be much less liability of injury by passing boats.

During the fiscal year 4,954 vessels passed through the canal, representing an undertonnage of 1,226,455 tons. Besides general merchandise these vessels carried 17,311,300 bushels (692,000 tons) of coal, 13,335 tons of iron ore, and 26,395 bushels of salt.

The receipts from dredging for private parties and from rent of dry-dock and houses amounted to \$1,023.75, which sum has been placed to the credit of the Treasurer of the United States.

During the year there was expended in the care and maintenance of

the canal \$61,333.14, of which \$4,008.91 was due to damages caused by the unprecedented flood of last February.

During the fiscal year 1883-'84 it is estimated that \$77,740 will be required for the proper maintenance of the canal. Of this sum \$6,000 is for repair and removal of the Thénard shutters, \$22,000 is for the reconstruction of the middle miter sill, which has yielded to the water pressure, and \$5,000 is for contingencies. The estimate made a year ago for the present fiscal year was \$40,220. The increase is due to the unavoidable necessity of repairing unexpected damages that occurred during the fiscal year just ended, and to the addition of \$5,000 to cover similar unforeseen contingencies that may occur during the present year.

For the fiscal year 1884-'85 the estimate is \$128,540. Of this sum \$2,000 is for new boilers for the dredge-tender, \$3,000 is for pumps for the speedy removal of the heavy deposits of mud left by every rise, and also for fire purposes, \$25,000 is for a new dredge, and \$53,200 is for a high-water lock.

The necessity for a new dredge is due to the fact that one of the present dredges is worn out in hull and machinery, and is unfit for service. After every rise in the Ohio the locks become choked with mud, and navigation is stopped until the mud can be removed. The magnitude of the Louisville and Portland Canal, the large sums that have been expended in its construction, and the immense commerce that is served by it, all call for the best attainable operating machinery. The two dredges now on hand have been in use on the canal for twenty-three years, were second-hand when originally procured, and are incapable of performing such service as the interests of the canal require. They are equipped with second-class machinery of patterns that are now obsolete. It is proposed to gradually replace these worn out dredges by new ones, with such improved machinery as will enable them to handle mud with the required speed. During the past fiscal year the two dredges now in service averaged only 572 cubic yards per working day, which is but a small average for one dredge under the existing conditions of work. It is proposed to make the new dredges of iron, like those that have done such good service on the Ohio.

The need of a new high-water lock has been so fully set forth by Lieutenant Colonel Weitzel in his annual and special reports that it is unnecessary for me to do more than signify my hearty concurrence in his recommendation. At present, during the stages of from 11½ to 15 feet on the gauge at the head of the falls ascending navigation is stopped because the canal is closed, and the current on the falls is too strong to be stemmed. The proposed high-water lock will maintain navigation through the canal until the falls become practicable. Its construction is earnestly advocated by all navigators of the Ohio River, and in my judgment it is a work of public necessity.

The expenditures for permanent repairs during the nine years since the Government took charge have been about \$171,900.

For further details reference is made to the annexed report of Mr. P. J. Schopp, superintendent of the canal.

Financial statement for the fiscal year ending June 30, 1883.

Receipts.	Amount.	Expenditures.	Amount.
Rents.....	\$198 75	Office and general administration ...	\$8,552 10
Dry-dock.....	447 50	Canal and locks	33,038 47
Dredging.....	217 50	Dredging.....	17,050 39
Pumping.....	160 00	Improvements	2,692 18
Total.....	1,023 75	Total.....	61,333 14

APPROXIMATE ESTIMATE OF EXPENDITURES ON THE LOUISVILLE AND PORTLAND CANAL FOR THE FISCAL YEAR ENDING JUNE 30, 1884.

Regular pay-rolls	\$31, 140
Miscellaneous, fuel, oil, &c.....	4, 700
Extra labor	1, 500
General repairs	6, 900
New upper gates, new locks (unfinished work from last year).....	500
Removal and repair of Thénard shutters.....	6, 000
Reconstruction of middle sill, new locks.....	22, 000
Contingencies.....	5, 000
	77, 740

APPROXIMATE ESTIMATE OF EXPENDITURES ON THE LOUISVILLE AND PORTLAND CANAL FOR THE FISCAL YEAR ENDING JUNE 30, 1885.

Regular pay-roll	\$31, 140
Extra labor	1, 500
Miscellaneous, fuel, oil, &c.....	4, 700
General repairs	3, 000
New boilers for dredge-tender	2, 000
New iron dredge	25, 000
High-water lock and gates	53, 900
Mud washing apparatus	3, 000
Contingencies.....	5, 000
	128, 540

Detailed statement of expenditures for operating and maintaining Louisville and Portland Canal for fiscal year ending June 30, 1883.

Month.	Office and general administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Current repairs.	Total.
1882.								
July	\$580 00			\$580 00	\$1, 075 00	\$28 92	\$189 86	\$1, 293 28
August	580 00		59 52	639 52	1, 025 00	134 13	3, 034 88	4, 194 01
September	580 00		68 71	648 71	1, 070 00	161 00	809 66	2, 080 66
October	580 00		152 74	732 74	1, 273 32	252 68	2, 744 27	4, 270 27
November	580 00		20 79	600 79	1, 129 83	47 80	2, 306 44	3, 488 67
December	696 67	26 00	12 00	737 67	1, 110 83	825 06	998 67	2, 434 56
1883.								
January	667 50	5 50	228 16	901 16	1, 122 75	111 76	182 00	1, 416 51
February	785 00		16 38	801 38	1, 100 00	117 97	562 58	1, 780 55
March	635 00	73 01	86 82	794 83	1, 125 00	228 00	1, 636 02	2, 989 02
April	580 00	23 00	29 05	632 05	1, 180 00	140 28	2, 332 88	3, 653 16
May	755 00	18 95		773 95	1, 180 00	83 94	784 10	2, 048 04
June	755 00	5 80		760 80	1, 180 00	158 13	2, 106 71	3, 444 84
Totals	7, 774 17	154 26	623 67	8, 552 10	13, 571 23	1, 779 67	17, 687 67	33, 038 47

Month.	Dredging.				Improvements.	Grand total.
	Labor.	Supplies.	Current repairs.	Total.		
1882.						
July	\$907 87	\$54 28	\$126 39	\$1, 088 54		\$2, 961 82
August	978 53	836 20	1, 068 32	3, 333 06	748 56	8, 915 15
September	835 00	437 03	*889 70	2, 161 73	1, 875 82	6, 716 42
October	841 35	245 75	27 79	1, 114 89	68 30	6, 186 20
November	835 00	77 73	187 86	1, 100 59		5, 184 95
December	835 00	347 20	316 96	1, 499 16		4, 671 89
1883.						
January	835 00	102 54	204 25	1, 141 79		3, 459 46
February	924 88	66 50	48 96	1, 040 29		3, 622 22
March	890 02	211 97	3 40	1, 105 39		4, 838 74
April	839 34	237 50	173 89	1, 250 73		5, 684 94
May	853 87	245 45	23 60	1, 123 01		3, 945 00
June	835 00	242 25	188 96	1, 091 21		5, 296 85
Totals	10, 410 81	2, 654 40	4, 160 18	17, 050 39	2, 692 18	61, 333 14

* This item includes \$725 paid for hire of steamboat to take place of dredge-tender during repairs of latter.

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ANALYTICAL STATEMENT SHOWING TIME EMPLOYED BY DREDGES AND THE AMOUNT AND COST OF DREDGING AT THE LOUISVILLE AND PORTLAND CANAL FOR THE YEAR 1882-'83.

Time dredging.....	days..	196
Time lost:		
Sundays and national holidays	do...	58
Repairs	do...	16
Other work	do...	21
Coal runs	do...	29
High water	do...	41
Ice	do...	4
		<hr/> 365
Deposit removed during season	cubic yards..	112,090
Deposit removed per day	do.....	571.69
Salaries, for the year		<hr/> \$10,410 81
Salaries per day		28 52
Repairs and supplies for the year		6,814 58
Repairs and supplies per day		18 67
Total expenditure for the year		17,050 39
Cost per day of actual dredging		86 99
Cost per cubic yard excavated		15

Abstract of proposals for furnishing coal for use at the Louisville and Portland Canal, received and opened by Lieut. Col. William E. Merrill, Corps of Engineers, on June 23, 1883.

No.	Bidders.	9,900 bushels Youghiegheny coal.	22,500 bushels Ohio River or Kana- wha coal.	Aggregate of bid.
		<i>Per bushel.</i>	<i>Per bushel.</i>	
1	Austin H. Dugan	\$0 10½	\$0 08½	\$3,017 25
2	O'Neill & Company	11	9½	3,142 12
3	Byrne & Speed	11	9½	3,226 50

Statement of vessels passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1883.

Month.	Number of lock- ages.	Passenger boats.		Tow-boats.		Model barges.		Coal boats.	
		No.	Under- tonnage.	No.	Under- tonnage.	No.	Under- tonnage.	No.	Measured capacity, tons.
July	171	89	31,252	64	7,875	24	7,337	10	4,300
August	202	109	34,461	66	6,551	25	8,848		
September	212	127	37,409	56	4,381	36	10,925	1	430
October	259	127	34,803	76	5,544	23	5,999		
November	242	137	38,836	59	5,079	35	8,485	3	1,280
December	229	135	49,321	60	6,195	33	8,667	18	7,744
January	153	77	31,137	36	5,361	26	7,560	55	23,050
February	28	10	4,188	7	609			8	3,440
March	249	74	35,350	101	11,814	43	11,600	74	30,164
April	89	21	10,006	32	3,817	12	3,316	79	33,712
May	384	90	39,041	102	13,702	66	16,354	101	87,744
June	289	73	34,104	110	15,578	67	21,090	116	49,310
Totals	2,437	1,069	379,912	769	87,651	390	111,171	465	241,789

Statement of vessels passed through the Louisville and Portland Canal, &c.—Continued.

Month.	Square barges.		Small boats.	Rafts.	Government boats.		Total.	
	No.	Measured capacity, tons.	No.	No.	No.	Undertonnage.	No. of vessels.	Undertonnage.
July.....	92	17,905	16	.....	6	.....	301	68,669
August.....	57	11,289	21	.....	11	.....	289	61,129
September.....	111	23,437	11	.....	14	.....	356	77,132
October.....	144	25,388	54	1	16	.....	441	71,734
November.....	128	21,328	30	.....	11	.....	403	76,020
December.....	194	38,173	23	.....	9	.....	472	110,066
January.....	108	23,575	19	.....	.....	.....	321	91,883
February.....	9	1,290	.....	.....	.....	.....	34	9,527
March.....	346	81,713	10	.....	4	.....	652	170,641
April.....	67	14,663	2	.....	1	52	214	65,568
May.....	331	68,859	9	.....	24	1,793	723	227,498
June.....	342	74,344	19	2	19	1,820	748	196,241
Totals.....	1,929	401,944	214	3	115	3,665	4,954	1,226,123

The total cost of passing boats and freight through the canal during the past fiscal year, including all expenditures, except for improvements, was—

Per lockage.....	\$24 06
Per boat.....	11 84
Per ton.....	04½

The cost of lockage, exclusive of expenditures on account of dredging, was—

Per lockage.....	\$17 07½
Per boat.....	8 40
Per ton.....	03½

CUSTOMS RECEIPTS AT THE PORT OF LOUISVILLE.

This work is in the Louisville collection district. During the fiscal year ending June 30, 1883, the receipts from customs at this port were \$95,599.23, of which \$529.50 was on goods that came up from New Orleans by river.

REPORT OF MR. P. J. SCHOPP, SUPERINTENDENT OF LOUISVILLE AND PORTLAND CANAL.

LOUISVILLE, KY., July 1, 1883.

SIR: I have the honor to submit herewith my report upon operating and care of Louisville and Portland Canal for the fiscal year ending June 30, 1883.

The last year was favorable to navigation on the Ohio River, and was noteworthy for the occurrence of the highest flood on record. During the year the canal was in operation three hundred and four days; it was closed by high water fifty-seven days and by ice four days. The large locks were closed ten days, during which time boats passed through the old locks; navigation was therefore uninterrupted during the low-water season.

During the period of navigation, 4,954 vessels, representing an undertonnage of 1,226,455 tons, and carrying 17,311,300 bushels of coal, 13,335 tons of iron ore, and 26,395 barrels of salt, besides miscellaneous freight, passed through the locks.

At the entrance of the canal an additional length of 336 feet of the guiding dike was raised to the 12-foot mark of the canal gauge, making the present length of raised dike 660 feet.

The flood, which reached its highest stage on February 16, 1883, being then 3.05 feet higher at the locks than the memorable flood of 1832, did considerable damage to the canal bank and fences, the greatest injury being a break on the north side of the canal near the old locks. Part of the fences were washed away, and the remainder were so much damaged that the entire length from the railroad bridge to the locks had to be rebuilt. The break in the canal bank has been filled up, and the bank has been raised.

The old retaining-wall on the north side of the canal was damaged in several places by passing boats, and had to be repaired.

In the dry-dock the old and rotten blocks and slides were replaced by new ones.

The old locks were provided with a new set of upper lift-gates, and also with new windlasses for all the lift-gates, a much needed improvement. These locks are now, as far as the locking apparatus is concerned, in good order.

The side walls are rugged and dilapidated, but as extensive improvements are in contemplation which will do away with the old locks, it would not be advisable to rebuild them.

At the new locks the wooden suspension columns for the upper gates have been replaced by iron ones. A new pair of upper gates will be erected during the coming season of low water. One leaf of these new gates has been launched, and the other is in course of construction.

During the year the lower lift-gates, which were no longer serviceable, were replaced by new ones. Two new steel boilers, one for each side of the locks, were received. They furnish steam for the gate machinery of all the gates.

The masonry of the middle sill has been somewhat damaged, and is in a leaky condition. Repairs in the low-water season will be necessary. The masonry of this sill has given frequent trouble on account of its original faulty construction. At some future time it will be necessary to entirely reconstruct it. As this will be a work of some magnitude, proper arrangements should be made to procure material in time, and to work it into shape.

The very large deposit of sediment which is left on the lock walls and in the boiler and engine houses during freshets makes it necessary that more effective means should be adopted for the quick and thorough removal of this material while it is in a half liquid state, and before it has time to harden. The small stationary pumps at the locks are not sufficient, and the heaviest work is now done by the large pump on board the dredge-tender Walker Morris; but as soon as the water is sufficiently low for dredging the tender must be withdrawn from washing the walls, and consequently a large pile of mud has to be left on the lower lock walls until it can be removed late in the season. This neither looks well, nor is it beneficial to health. With two pumps of a larger capacity and proper pipe and hose connection the flushing could be done in time independently of the dredge-tender, and the place could be kept clean. I therefore recommend the purchase of two pumps, and the introduction of a perfect flushing system.

The dredge-tender was provided with new cylinder timbers and a new deck and guards; her engines were also repaired. Her boilers are now seventeen years old, and she should be supplied with a new pair. One of the mud-scows was almost entirely rebuilt.

As the hull of one of the dredges must soon be replaced, and as the machinery is of an old pattern that by long service has nearly worn out, it is proposed to build a new dredge with improved machinery and larger working capacity.

It sometimes happens that on a rising or falling river the large locks are closed before there is a sufficient depth on the falls for the passage of deeply loaded boats, which are thus compelled to wait. An additional set of gates above the present high guard gates of the new locks would remedy the difficulty by forming, with the present upper lift-gates, an additional lock chamber for service in high stages.

During the year the boundary lines of the land belonging to the Louisville and Portland Canal were resurveyed and marked by stone monuments.

The number of regular canal employes is now forty, an increase of two over former numbers. The increase is in the lock force, and was necessary for greater efficiency in the service.

Charges for extra work of dredges, use of tow-boat, and dry-dock, were the same as in former years, viz, \$2.50 per hour for dredging, \$2.50 per hour for use of steam-pump, and harbor rates for extra towing. For the use of dry-dock \$15 for the first day and \$10 for each subsequent day.

The receipts from extra work of dredging, use of dry-dock and tow-boat, and rent during the fiscal year amount to \$1,023.75.

The total expenditures during the fiscal year were \$61,333.14, of which \$3,693.18 have been for permanent improvements.

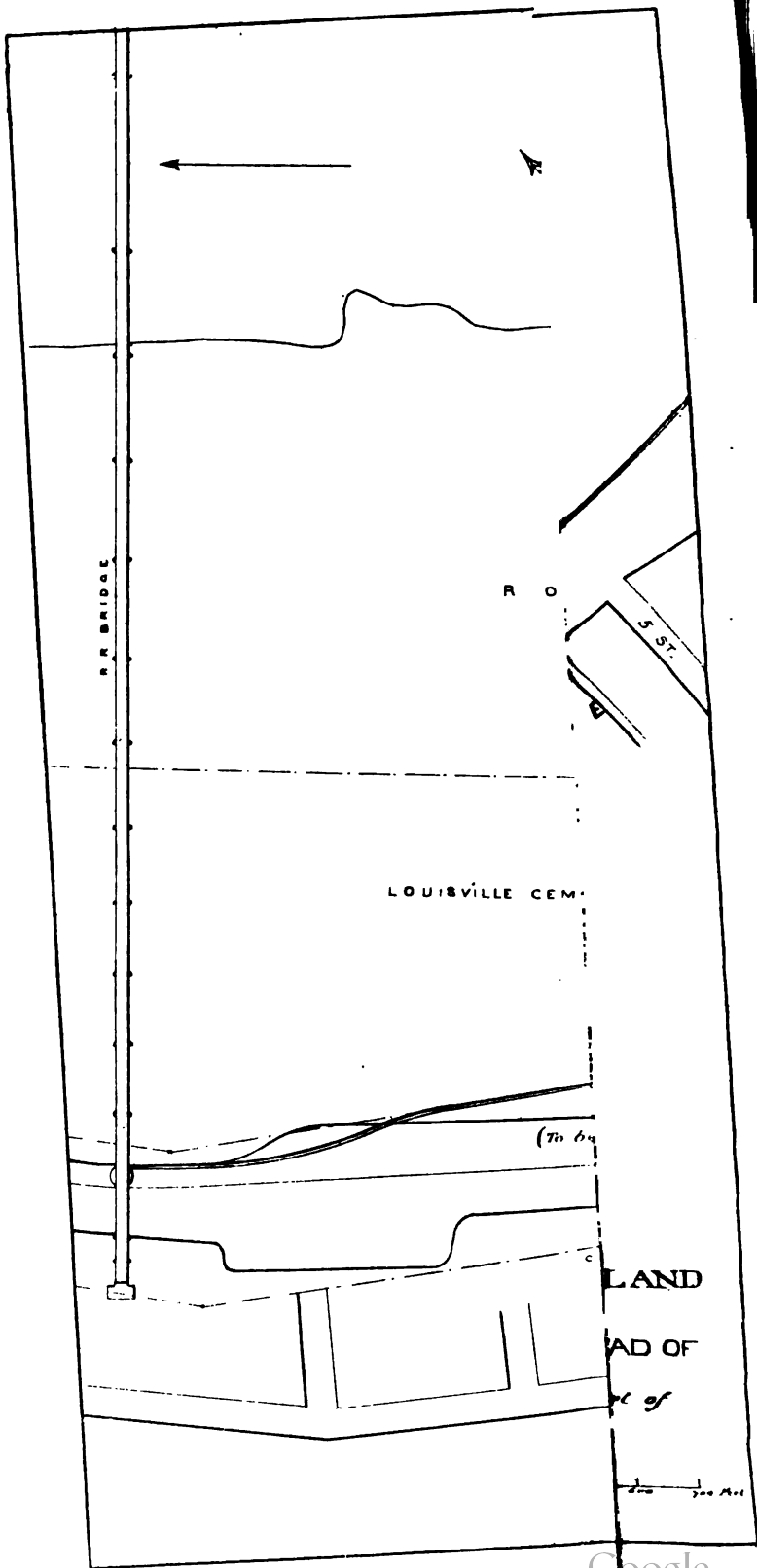
Special estimates for the fiscal years 1883-'84 and 1884-'85 are submitted. The estimate for 1883-'84 had to be increased on account of repairs not expected when an estimate was submitted at the end of June, 1882. The estimates are based on expenditures that are now anticipated; besides this it is essential that there should be a fund for contingencies.

Tables carefully prepared from records kept in this office are also submitted for comparison with those published in former years.

Very respectfully, your obedient servant,

PHIL. J. SCHOPP,
Superintendent Louisville and Portland Canal.

Col. WM. E. MERRILL,
Corps of Engineers, U. S. A.



SPECIAL REPORT ON IMPROVEMENT OF THE FALLS OF THE OHIO RIVER.

In January, 1882, the Senate of the United States called for a special report on the improvements still needed at the Falls of the Ohio to serve the interests of the commerce of the Ohio River. This report was made under date of February 10, 1882, by Major (now Lieutenant-Colonel) Weitzel, and is printed in the Annual Report of the Chief of Engineers, 1882, page 1880 *et seq.*

As Colonel Weitzel's successor, it has devolved upon me to take up the subject where he left it, and to carry it on with such additions and improvements as further experience and study might suggest.

The chief improvement which he recommends is an independent coal canal, in order to prevent the stoppage of other kinds of traffic when a coal run arrives at Louisville.

Such a canal would be an excellent solution of the difficulties that now embarrass navigation, but I am reluctantly compelled to report that, in my judgment, it is not practicable at the present. The insurmountable obstacle is the fact that its construction would wholly destroy the immense cement interest of Louisville, that would thus be deprived of access to its quarries.

The cement mills and quarries could doubtless be condemned and purchased, but the condemnation price would be more than the project could bear, even if the injury to the interest of the public by the extinguishment of so important an industry were left out of consideration.

I therefore feel compelled to submit, in lieu of the independent coal canal, a project for as great an enlargement of the upper half of the canal as can be made *without interfering with the cement interests*. Whenever, as will happen in the course of time, the cement rock is worked out and the quarries are abandoned, it will be practicable to complete Colonel Weitzel's plan at a great saving over his present figures, as all of the costly rock excavation for which he has estimated will be done by the cement companies in their pursuit of cement rock.

The project which I therefore submit, as the best now attainable, will give great relief to the canal, and will be an inestimable boon to the city of Louisville by furnishing ample harbor room, and by greatly lessening the annoyance from mud, ice, and drift. It contemplates enlarging the present canal by moving its northern wall to the northern line of the canal property, commencing at the pivot pier of the railroad bridge and extending eastwardly to the intersection with the eastern boundary line of the property of the Louisville Cement Company. At this point will be the new head of the canal, and it will be connected with the existing dam on the crest of the falls by a similar dam along the eastern line of the cement company's property to its northeastern corner, thence by a straight line to the southern end of the opening for the Middle Chute. The accompanying map shows the proposed enlargement, and its relations to the existing canal. The most expensive part of this and all other plans for the enlargement of the head of the canal is the necessity of excavating to canal bottom the rocky ledge that forms the falls, which has to be lowered from 3 to 4 feet.

The estimated cost of the modification herein recommended is as follows:

Rock excavation.....	\$1,089,411
Earth excavation.....	84,650
Removing canal wall.....	15,196
Removing river wall.....	15,288

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New retaining-wall	\$47,400
Removing part of dam	4,230
2,600 feet of new dam	15,600
Contingencies, 5 per cent	63,588
Total	1,335,363

As the estimate for the independent coal canal was \$3,102,517, the adoption of the proposed modification will cause a present saving of \$1,767,154, with the advantage that everything done under this project will fit into the larger project whenever the time comes for its execution.

The present entrance into the canal is contracted and dangerous. The head of the guiding dike is now ornamented with the wreck of a fine passenger steamboat, the Buckeye State, that got caught while trying to land at the Louisville wharf. The proposed improvement would make the harbor of Louisville as safe as any on the Ohio River, and at the same time it would make the canal accessible at all stages without danger or difficulty.

As the work should be done as soon as possible, I would recommend an appropriation of \$500,000 for "enlarging Louisville and Portland Canal."

LAWS OF THE STATE OF KENTUCKY AND OF THE UNITED STATES RELATING TO THE LOUISVILLE AND PORTLAND CANAL.

As difficult questions are constantly arising in connection with the Louisville and Portland Canal whose solution depends upon past legislation of the State of Kentucky and of the United States, I have thought it advisable to collect in one body all such legislation. I therefore annex for publication, in connection with this report, copies of all laws affecting this canal that have thus far been passed by either the State or the United States.

AN ACT to incorporate the Louisville and Portland Canal Company.

SECTION 1. *Be it enacted by the general assembly of the commonwealth of Kentucky, That Nicholas Berthoud, Robert Ormsby, James Hughes, John D. Colmesnil, Robert Breckenridge, Isaac Simeon, S. Goodwin, Charles M. Thurston, Worden Pope, William S. Vernon, John I. Jacob, Samuel Churchill, James Brown, James H. Overstreet, Daniel Felter, James Guthrie, with their associates, be, and they are hereby created a corporation and body politic, by the name, style, and title of "The Louisville and Portland Canal Company," for the purpose of opening and constructing a canal navigation with suitable locks, docks, and basins, around the falls of the river Ohio, within the State of Kentucky; and they, with their associates and successors, shall so continue and have perpetual succession, and by that name are hereby made as capable in law, as natural persons, to contract and be contracted with, to sue and be sued, plead and be impleaded, answer and be answered, in all courts of law or equity in this commonwealth, and elsewhere; to make, have, and use a common seal, and the same to break, alter, or amend at pleasure. They shall also have the power to purchase and hold as much real estate as will be necessary for site of said canal, roads, buildings, docks, basins, and the proper application of the water power, or use of water that may arise from the proper construction of said canal, with power to make as many dry and wet docks as they may deem advisable; and also to borrow money to any amount not exceeding the capital stock hereinafter mentioned, but not to have or exercise the power of loaning money, or buying or selling bills of exchange, or other choses in action, or issuing notes on banking principles; also, the power to ordain and establish such by-laws, ordinances, and regulations as shall be necessary for the well-being and government of the concerns of said corporation, not contrary to the constitution and laws of this commonwealth, or of the United States.*

SEC. 2. That the capital stock of said company shall consist of six hundred thousand dollars, divided into shares of one hundred dollars each, to be subscribed for in the manner hereinafter mentioned.

SEC. 3. That within thirty days from the passage of this act the persons hereinbefore named, or a majority of them, shall cause a public advertisement to be made of the time and places of opening books for the subscription of the stock of said company, which books of subscription shall be kept open, under the direction of the aforesaid persons or a majority of them, not less than ten days nor more than ninety days. If, however, at the closing of the subscription, it shall be found that a greater number of shares shall have been taken than the number of six thousand, then and in that case the persons aforesaid or a majority of them shall proceed to reduce the subscription in an equitable proportion among the subscribers, taking off from the largest subscribers, not reducing any one below ten shares.

SEC. 4. That, whenever one thousand shares of the capital stock of said company shall have been subscribed, the persons aforesaid or a majority of them shall advertise a meeting of the shareholders of said company in Louisville, giving at least fifteen days' notice of the time and place of such meeting, and shall thereupon proceed to the election of a president and four directors, who shall be shareholders in said company, and also fix what compensation they shall be entitled to, if any is allowed; and also to ordain and adopt such other permanent by-laws for the organization of the said corporation as they may deem needful; in which meeting, as well as at all future meetings or elections, each shareholder shall be entitled to one vote for every share he may hold to the number of twenty, and one vote for every ten shares over twenty; but after the first general meeting and election, no person who is not a citizen of the United States shall vote on any shares in said company, either in person or by proxy. At all subsequent elections no shares shall be voted on that have not stood in the name of the person claiming to vote at least three months previous to the day of election. Shares may be voted on by proxy duly recorded and conforming to the foregoing qualifications.

SEC. 5. That the president and directors first so chosen shall hold their offices until the first Monday of January, eighteen hundred and twenty-six, or until others shall be chosen in their places. On the first Monday in January in each year, the stockholders of said company shall meet at their office, in some place to be designated by the president and directors, in Louisville, and there proceed to choose a president and four directors, who shall be shareholders in said company and resident citizens of the United States, and who shall hold their offices for one year, and until others shall be elected in their places. Public notice of such meetings and elections to be given by the clerk or secretary of the company in some public newspaper printed in Louisville, Frankfort, and Cincinnati, at least fifteen days previous to any such meeting or election. At the annual meetings a statement of the affairs of the company shall be made out and presented to the meeting by the president and directors, and such dividend of the profits declared as they may deem advisable.

SEC. 6. That the concerns of said corporation shall be under the control, superintendence, and management of the said Board of president and directors, a quorum of which, to do business, shall consist of the president and two directors, or, in the temporary absence of the president, of three directors, who may appoint one of their number as president pro tem. The president and directors may, after they shall have been duly elected as aforesaid, make such assessments on the shares subscribed and payable at such periods as they may deem proper, with such conditions of forfeiture for non-compliance, not exceeding the amount of the stock delinquent, as they may deem advisable. They may open or renew the subscription for the shares not already subscribed or dispose of them in any manner that they may think for the interest of the company: *Provided, however,* That they shall not sell any stock or share in said company at less than the par value thereof; and also that proper notice of the time and place of said subscription or sale is given in one or more public newspapers printed in Louisville, Frankfort, and Cincinnati.

SEC. 7. That it shall be the duty of said president and directors to appoint a clerk or secretary, a treasurer, and such other officer or agents as they may think needful for prosecuting the said undertaking, and to allow them such pay or compensation as they may agree on; to make contracts, and do all things necessary for carrying the same into immediate effect; and to require and take such bonds or other security in their corporate name from any person or persons they may so appoint or contract with. In case of the death, resignation, or vacancy from any other cause in the said Board of president and directors, the remaining members may proceed to appoint a stockholder or stockholders to supply the place or places of the president, director, or directors so vacated, for the unexpired time for which he or they were elected.

SEC. 8. That the president and directors of said company, by themselves or their agents or workmen, shall have full power to enter into and upon any lands in the vicinity of the proposed canal, and to survey and lay out such route or track as shall be deemed by them most practicable for effecting a safe and easy navigation, and also for suitable locks to it, and dry-docks suitable for such objects as are within the contemplation of this act and the organization of this company, doing as little injury to the adjoining grounds and inclosures as is possible in the execution of the

proposed undertaking; and it shall and may be lawful for the owners of the lands and tenements to contract and agree with the said president and directors for the conveyance of so much of said lands as will be necessary and requisite for the purpose aforesaid, if the president and directors can agree with said owners; but in case of disagreement said company may proceed to lay out and open their works on such grounds as they may deem best adapted to the purposes of navigation, water-works, wet and dry docks, and basins connected with the same; and on application of either party to the circuit court of Jefferson County, the said court shall appoint twelve persons, who shall be freeholders, disinterested, to view and assess the damages and advantages arising to the said owners by the location of the said works, and make report thereof to said court, which report, when duly received and admitted to record, shall be final, and on payment of the money, if any is awarded, shall vest in the said company the fee-simple to the land. The president and directors shall likewise have power to sell or lease for a term of years the privilege of erecting docks or other locations on the said canal or its appendages.

SEC. 9. That it shall be lawful for the said president and directors by themselves or their agents to enter with such force as they may employ for that purpose upon the lands contiguous or near to the proposed canal, and from thence to take and carry away any earth, stone, timber, gravel, &c., being most convenient for making, or repairing the said canal and appendages, making proper compensation therefor to the owners of said land if they can agree therein; but in case of disagreement, then it shall be settled by valuation in the manner before recited. And when the said canal shall be completed, suitable for the passage of boats drawing four feet of water in low stages of water, the said president and directors by themselves, their agents and servants, shall have power and authority to demand and receive from the owner or owners, master or agents, of all vessels, boats, barges, or other craft entering the said canal, the following rates of toll, to be paid before the said vessel, boat, barge, or craft shall be suffered to pass through the same, to wit: For steamboats, sea vessels, barges, or keel-boats, twenty cents per ton, United States measurement; for each flat-boat, four dollars; for each raft of timber, plank or other lumber, four dollars for every sixty feet in length, not exceeding twenty feet in width. The said tolls to be paid in gold or silver coin, current in the United States; and in no event shall any law be passed requiring or compelling to receive any other currency in discharge of toll. The said president and directors shall fix and establish such sums as they may deem advisable for the use of the docks, basins, and other appendages to the said canal; which rates, with the foregoing rates of toll, shall be posted up in some conspicuous place on the said canal, and no other or greater rates shall be demanded than those posted up.

SEC. 10. That if any person or persons shall willfully and knowingly do any act or thing whatever, whereby the said navigation or any lock, gate, dam, engine, machine, or other thing thereto belonging, shall be injured or damaged or impeded, or shall commit any willful trespass, or take, carry away, or conceal any material, instrument, tool, or other thing belonging to, or used in or about the said works, or shall open or cause the locks to be opened, or attempt so to do, or to pass or repass without the knowledge of the agent or manager to said canal, he, she, or they so offending shall forfeit and pay to the said canal company, their tenant or agent, three times the amount of the cost or damage sustained by means of, or through such willful act, together with costs of suit, to be recovered before any court of competent jurisdiction, and in case of clandestinely taking and carrying away, be liable to a prosecution for theft, as in other cases.

SEC. 11. That the said president and directors shall keep a true account of the cost and expenditure of the said canal and appendages, and on the first Monday in January of each year have the same made up, and the balance of profit struck and divided among the stockholders, and report the same to the general assembly of this commonwealth; and if it shall appear by the said return so made under the oath of the president and directors, that the profits so divided do not amount to twelve and one-half per cent. on the capital expended, the said corporation shall be authorized to add to the tolls for the succeeding years until the net profits, after deducting for all expenses, repairs and necessary improvements, shall amount to twelve and one-half per cent. per year. But should it appear by the said returns that the net profits as aforesaid exceed eighteen per cent. per year after the expenses, repairs, and necessary improvements are made, the legislature reserve to themselves the right so to reduce the rate of tolls as that the profits to be divided shall not exceed eighteen per cent. per annum.

SEC. 12. That the trustees of the town of Louisville shall have a right to subscribe for and take any amount of stock in this company or corporation, not exceeding one thousand shares, and that whatever sum which may be so subscribed for and taken by the trustees aforesaid, not exceeding \$100,000, shall not be reduced by anything in the third section in this act contained; and that said trustees and their successors shall be entitled to the same rates as other subscribers or stockholders, and not otherwise; which stock may be subscribed for by the president or chairman of the

Board of trustees for the time being, and the rates to which they may be entitled may be given either by the president or chairman of said Board for the time being, or such other person as they may appoint: *Provided*, That such subscription by such trustees be made within thirty days from the time of opening the books for subscribing of stock. And to enable said trustees to raise and borrow the necessary funds to meet and pay up their subscriptions of stock, the said trustees and their successors may pledge the amount of stock so subscribed and taken, as well as their interest or profits arising from the proposed canal, dry and wet docks, and other appendages, as well as any other funds or property they may possess as trustees aforesaid.

SEC. 13. That the stock in said canal company shall and may be transferable in whatever manner the president and directors of said canal may by their by-laws ordain and appoint.

SEC. 14. That unless the said company shall within eighteen months from the passage of this act, *bona fide*, commence the cutting of said canal, or shall fail, within three years from the passage of this act, to have the main object of their charter, to wit, the canal itself, completed, the corporate powers hereby granted shall cease and determine: *Provided*, That if the said stock shall not be subscribed and notice given by the company to the governor of the commonwealth on or before the first day of November next, then this charter shall cease and be void, and all rights and privileges become null and void to all intents and purposes, as if this act had not passed.

Approved January 12, 1825.

AN ACT to amend an act entitled "An act to incorporate the Louisville and Portland Canal Company."

Be it enacted by the general assembly of the commonwealth of Kentucky, That so much of the fourteenth section of the above act, entitled "An act to incorporate the Louisville and Portland Canal Company," as requires the canal, by said act authorized, to be completed within three years from the passage of said act, be, and the same is hereby, repealed: *Provided*, That the said canal be completed within three years from the passage of this act.

Approved December 20, 1825.

AN ACT to authorize a subscription for stock on the part of the United States in the Louisville and Portland Canal Company.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Treasury be, and he hereby is, authorized and directed to subscribe for, or purchase in the name and for the use of the United States, not exceeding one thousand shares of the capital stock of the Louisville and Portland Canal Company, and pay for the same at such times and in such proportions as may be required of and paid by other stockholders of said company, out of any money in the Treasury not otherwise appropriated: *Provided*, Said shares can be procured for a sum not exceeding one hundred dollars each.

SEC. 2. *And be it further enacted*, That the Secretary of the Treasury shall vote for president and directors of said company, according to such number of shares, and shall receive upon the said stock the proportion of the tolls which shall from time to time be due to the United States for the shares aforesaid.

Approved May 13, 1826.

AN ACT allowing further time for completing the Louisville and Portland Canal.

Be it enacted by the general assembly of the commonwealth of Kentucky, That the further time of sixty days after the time now allowed by law be, and the same is hereby, allowed the president, directors, and company of the Louisville and Portland Canal to finish the same.

Approved, February 6, 1828.

AN ACT giving further time for the completion of the Louisville and Portland Canal.

Be it enacted by the general assembly of the commonwealth of Kentucky, That the further time of two years from and after the sixth day of February, eighteen hundred and twenty-nine, be, and the same is hereby, given for the completion of the Louisville and Portland Canal.

Approved December 11, 1828.

AN ACT to authorize a subscription for stock on the part of the United States in the Louisville and Portland Canal Company.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Treasury be, and he hereby is, authorized and directed to subscribe for or purchase in the name and for the use of the United States any stock which may have been forfeited to the company, and which shall be undisposed of on the fourth day of March next, not exceeding one thousand three hundred and fifty shares of the capital stock of the Louisville and Portland Canal Company, and to pay for the same, when called on by the said company, out of any money in the Treasury not otherwise appropriated: *Provided,* Said shares can be had for a sum not exceeding one hundred dollars each.

SEC. 2. *And be it further enacted,* That the said Secretary of the Treasury shall vote for president and directors of said company, according to such number of shares, and shall receive upon the said stock the proportion of the tolls which shall from time to time be due to the United States for the stock aforesaid.

Approved March 2, 1829.

AN ACT to enlarge the capital stock of the Louisville and Portland Canal Company.

SECTION 1. *Be it enacted by the general assembly of the commonwealth of Kentucky,* That the capital stock of the Louisville and Portland Canal Company shall be, and the same is hereby, increased from six hundred thousand dollars to the sum of seven hundred thousand dollars, and the president and managers of said company are hereby authorized to sell one thousand additional shares of stock in said company of one hundred dollars each, or to mortgage or pledge the same for a sum sufficient to complete the said canal.

Approved December 12, 1829.

AN ACT authorizing the Louisville and Portland Canal Company to increase their capital stock

Be it enacted by the general assembly of the commonwealth of Kentucky, That the Louisville and Portland Canal Company shall have the right, and are hereby authorized to extend their capital stock to such an amount as will be sufficient to pay all the costs and expenses of constructing said canal, and the interest on the sums expended by them in the construction thereof, up to the time said canal was open, and vessels passed through the same; and they may sell as many additional shares at one hundred dollars each as will pay said costs and interests; and they are required to report to the legislature of this State the number of shares sold under this act and the sum received for the same.

Approved December 12, 1831.

AN ACT to amend the charter of the Louisville and Portland Canal Company.

SECTION 1. *Be it enacted by the general assembly of the commonwealth of Kentucky,* That the act incorporating the Louisville and Portland Canal Company shall be, and the same is hereby, so amended, that whenever the stockholders in said company shall so direct, the Board of president and directors of said company shall have the privilege of selling the shares of stock owned by individuals in said canal to the United States, or the State of Kentucky, or the city of Louisville, for the purpose of eventually making the said canal free of tolls; or further, to effect this object, the Board of president and directors, when so authorized, as aforesaid, shall hereby have the privilege of appropriating the net income arising from said canal to the purchase of said stock, instead of making dividends therewith.

SEC. 2. *Be it further enacted,* That whenever said stockholders shall authorize said Board of president and directors to appropriate the annual net income of said company to the purchase of shares held by individuals in the same, it shall be the duty of said Board to advise each stockholder of the amount to be appropriated to the purchase of shares, and propose to purchase the number of shares that the sum on hand will warrant, at the lowest bid or offer. Thirty days' notice shall be given for such offers of stock to be made.

SEC. 3. *Be it further enacted,* That the maximum price at which the said Board shall purchase said shares for the first year shall not exceed the sum of one hundred and fifty dollars per share, and when the offers of said shares are made it shall be the duty of said Board to accept the lowest offers for the number of shares which the net income of the preceding year will allow them to purchase; and no dividends will be paid on the remaining shares of said company after the ratification of this amended

act; the maximum price paid for the shares purchased the first year, and six per cent. per annum annually added thereto, shall be the highest price which shall be paid for the shares in each subsequent year.

SEC. 4. *Be it further enacted*, That the shares so purchased by said Board shall be held in trust by it for the purposes herein declared, and shall be voted on by them at all subsequent meetings and elections, until by the operation of the provisions of this act all the shares standing in the name of others than the Government of the United States shall have been purchased up; and when the said shares shall be all purchased the same shall be transferred to the Government of the United States, on condition of said Government levying tolls for the use of said canal, only sufficient to keep the same in repair and pay all necessary superintendence, custody, and expenses, and make all necessary improvements, so as fully to answer the purposes of its establishment; and further to protect and guard the interests of commerce, the superintendents or agents in charge of said canal shall ever hereafter, on the first Monday in January, annually, report to the general assembly of Kentucky the amount of tolls levied and received, and of the charges and expenses incurred on the same, the general assembly reserving the right of directing the amount annually to be collected, if found too much for the purposes contemplated by this amended act.

SEC. 5. *Be it further enacted*, That it shall be the duty of said Board of president and directors to report to this general assembly, on the first Monday in January in each year the condition of the canal, and state the number of shares purchased and the amount paid for the same: *Provided*, That nothing contained in this act shall give said company the right to increase the toll allowed by the original charter.

Approved January 21, 1842.

AN ACT to amend an act entitled "An act to amend the charter of the Louisville and Portland Canal Company," approved January 21, 1842.

Be it enacted by the general assembly of the commonwealth of Kentucky, That in the event of the United States becoming the sole owner of the Louisville and Portland Canal, the jurisdiction of this commonwealth over said canal shall be yielded up to the Government of the United States, and no annual report, as mentioned in the charter of the Louisville and Portland Canal Company, shall be required to be made by the United States, or the agents and superintendents of said canal, to the general assembly of this commonwealth.

Approved February 22, 1844.

AN ACT to amend the charter of the Louisville and Portland Canal Company.

Be it enacted by the general assembly of the commonwealth of Kentucky, That the charter of the Louisville and Portland Canal Company be so amended as to authorize said company to construct, with the revenues and on the credit of the corporation, a branch canal sufficient to pass the largest class of steam vessels navigating the Ohio River, and said company are hereby vested with all the powers and authority to acquire and hold the necessary lands for said branch, and to construct the same, vested by the charter and amendments for the construction of the original canal, and all the provisions of the original charter and amendments shall, and are hereby, made as applicable to the branch as the original canal.

Approved December 19, 1857.

[No. 12] A RESOLUTION authorizing the enlargement of and construction of a branch to the Louisville and Portland Canal.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the president and directors of the Louisville and Portland Canal Company be, and they are hereby, authorized with the revenues and credits of the company, to enlarge the said canal and to construct a branch canal from a suitable point on the south side of the present canal to a point in the Ohio River opposite Sand Island, sufficient to pass the largest class of steam-vessels navigating the Ohio River: *Provided*, That nothing herein contained, shall authorize the said president and directors, directly or indirectly, to use or pledge the faith or credit of the United States for the said enlargement or construction. It hereby being expressly declared that the Government of the United States shall not be in any manner liable for said enlargement and construction: *Provided further*, That when said canal is enlarged and its branch canal constructed and its cost of said improvements paid for, no more tolls shall be collected than an amount sufficient to keep the canal in repair and pay for all necessary superintendence and management.

Approved May 24, 1860.

1546 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

JOINT RESOLUTION of the Kentucky legislature, March 26, 1872.

Whereas all the stock in the Louisville and Portland Canal belongs to the United States Government except five shares owned by the directors of the Louisville and Portland Canal Company, and said directors, under the authority of the legislature of Kentucky and the United States, executed a mortgage to Isaac Caldwell and Dean Richmond to secure bonds named in said mortgage, some of which are out and unpaid, and said canal company may owe other debts; and

Whereas it is right and proper that the Government of the United States should assume the control and management of said canal: Therefore be it

Resolved by the general assembly of Kentucky, That the president and directors of the Louisville and Portland Canal Company are hereby authorized and directed to surrender the said canal and all the property connected therewith to the Government of the United States, upon the following terms and conditions:

1. That the Government of the United States shall not levy tolls on said canal, except such as shall be necessary to keep the same in repair, pay all necessary superintendence, custody, and expenses, and make all necessary improvements.

2. That the city of Louisville shall have the right to throw bridges over the canal at such points as said city may deem proper: *Provided always*, That said bridges shall be so located as not to interfere with the use of the canal, and so constructed as not to interfere with its navigation.

3. That the title and possession of the United States of said canal shall not interfere with the right of the State to serve criminal and civil processes, or with the State's general police power over the territory covered by said canal and its appendages.

4. *And further*, That the city of Louisville shall at all times have the right of drainage into said canal: *Provided*, That the connections between the drains and the canal shall be made upon the plan to keep out mud and garbage.

5. That the use of the water-power of the canal shall be guaranteed forever to the actual owners of the property contiguous to said canal, its branches and dams, subject to such restrictions and regulations as may be made by the Secretary of the Department of the United States Government which may have charge of the said canal.

6. That the Government of the United States shall, before such surrender, discharge all the debts due by said canal company, and purchase the stock of said directors.

AN ACT making appropriations for the repair, preservation, and completion of certain public works on rivers and harbors, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

For completing the Louisville and Portland Canal, one hundred thousand dollars; and the Secretary of the Treasury is authorized and directed to assume, on behalf of the United States, the control and management of the said canal, in conformity with the terms of the joint resolution of the legislature of the State of Kentucky approved March twenty-eight, eighteen hundred and seventy-two, at such time and in such manner as in his judgment the interests of the United States, and the commerce thereof, may require; and the sum of money necessary to enable the Secretary of the Treasury to carry this provision into effect is hereby appropriated: *Provided*, That after the United States shall assume control of said canal the tolls thereon on vessels propelled by steam shall be reduced to twenty-five cents per ton, and on all other vessels in proportion.

Approved March 3, 1873.

AN ACT providing for the payment of the bonds of the Louisville and Portland Canal Company.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the appropriations made by the act approved March third, eighteen hundred and seventy-three, entitled "An act making appropriations for the repair, preservation, and completion of certain public works on rivers and harbors, and for other purposes," for the payment of the debts of the Louisville and Portland Canal Company, are hereby continued in full force, and are made permanently applicable to the payment of the debts of the said Louisville and Portland Canal Company; and so much as may be necessary shall be applied to the payment of the interest as it accrues, and the principal of the outstanding bonds of said company as they mature: *Provided, however*, That the Secretary of the Treasury may purchase and pay for any of said bonds at the market price, not above par, whenever he deems it for the interest of the United States.

SEC. 2. That after thirty days from the passage of this act the Secretary of War is hereby authorized and directed to take possession of the said Louisville and Portland

Canal, and all the property, real and personal, of said company as the property of the United States, as provided for by the act of the general assembly of the State of Kentucky approved February twenty-second, eighteen hundred and forty-four, entitled "An act to amend an act entitled 'An act to amend the charter of the Louisville and Portland Canal Company,' approved January twenty-first, eighteen hundred and forty-two," conceding jurisdiction over said canal to the United States, subject, however, to the mortgage lien on said property in favor of the trustees under said mortgage, and the holders of the bonds issued under it; and the Secretary of the Treasury is hereby authorized to pay the directors of said company for the stock held by them, which payment shall be made forthwith by the Secretary of the Treasury, being the sum of one hundred dollars to each director, with interest thereon at six per centum per annum since the ninth day of February, eighteen hundred and sixty-four; and he is authorized and directed to cause a careful and full examination of all the receipts and disbursements of the said company to be made, and to collect, and, if necessary, to sue for, any money due to or held for the said company by the directors of said company, or the trustees under said mortgage, or by any persons whatever. And said Secretary of the Treasury is hereby directed and empowered, immediately upon the passage of this act, to give public notice in such manner as in his judgment will best effect the purpose, to all persons and corporations having debts of any nature against said Louisville and Portland Canal Company, except the bonded debt thereof, to present them to him on or before the first day of July, eighteen hundred and seventy-five, and any such debt not presented on or before said day shall be forever barred. And said Secretary is hereby directed and authorized to examine, audit, and, in his discretion, allow such debts, or any of them, being hereby vested with any power necessary to that end; and he shall embrace his action in the premises in his succeeding annual report: *Provided, however,* That no sum of money shall be paid by the Secretary of the Treasury on account of any claim for either city or State taxes assessed, or to be hereafter assessed, against said company, or against the said canal property, or any of its appendages.

SEC. 3. That the said canal and property appertaining thereto shall be held for the common use and benefit of the people of the United States, free of all tolls and charges except such as are necessary to pay the current expenses of said canal, and to keep the same in repair; and for the present year they shall be at the rate of ten cents per ton capacity on vessels propelled by steam and five cents per ton on other vessels; and to ascertain what rates will pay current expenses after the present year, the Secretary of War shall, on the first Monday of January of each year, ascertain from the expenses of the previous year what tolls will probably pay the expenses of the current year; and he shall fix and declare the rate of tolls thus ascertained to be charged for the current year; and, until otherwise provided by law, the Secretary of War shall provide for the superintendence, management, and repair of said canal, and may apply the tolls so received, as far as may be necessary, to pay the current expenses of said canal; and he shall, in his next annual report, set forth such receipts and expenditures, and the condition of said canal, with a view to such legislation as may be necessary for the superintendence and management thereof; but no expenditure nor contract for expenditure of money shall be made under the authority of this section in any one year to an amount greater than the amount which may be received during such year from the tolls on said canal.

SEC. 4. That if at any time it become necessary to enforce the lien of the mortgage upon said canal property for the benefit of the bondholders, it shall be lawful for the trustees named in said mortgage, or any other trustees who may be appointed in pursuance of the laws of Kentucky, to commence proceedings therein in any court having jurisdiction thereof, with notice to the United States as *terre tenant pro forma*, and serve process upon any officer of the United States who shall have the superintendence of said canal, whose duty it shall be to notify the Attorney-General of the United States of such service; whereupon said Attorney-General shall enter an appearance in said case, and take all necessary steps to represent and defend the interests of the United States in such proceedings, so that the same may be conducted in the same manner and with the like effect as if the said Louisville and Portland Canal Company were still in existence as a corporation.

Approved, May 11, 1874.

CHAP. 95.—AN ACT to abolish all tolls at the Louisville and Portland Canal.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That after the first day of July, eighteen hundred and eighty, no tolls shall be charged or collected at the Louisville and Portland Canal, but the Secretary of War shall be authorized to draw his warrant from time to time upon the Secretary of the Treasury to pay the actual expenses of operating and keeping said canal in repair.

Approved, May 18, 1880.

Z 3.

IMPROVEMENT OF MONONGAHELA RIVER, WEST VIRGINIA AND PENNSYLVANIA.

As soon as practicable after the passage of the river and harbor act of August 2, 1882, Mr. L. M. Petitdidier, assistant engineer, was put in local charge of the Government improvements on this river, with instructions to begin the construction of Lock No. 8, at the mouth of Dunkard Creek.

The work of clearing away brush and small trees from the site of the lock was begun on September 2, and from that date until the close of operations on November 30 the work was pushed as rapidly as the weather and the stage of the river would permit.

A coffer-dam, 122 feet long and 115 feet wide, was built to inclose the upper end of the lock, and at the close of the season the foundations of both walls of the lock for a length of 23 feet, the whole of the cross-wall at the head of the lock, and 32 feet of the wing-wall had been built to a height of 3 feet above low water.

Amount of masonry laid, 810 cubic yards.

The contractors for furnishing the stone for this lock (Messrs. Shipman and Carmody, contract of July 28, 1881), have thus far delivered 6,136 cubic yards of the 10,325 cubic yards of stone called for by their contract. The entire quantity required will undoubtedly be delivered by the time another appropriation will warrant the resumption of work on the lock.

No work of construction will be attempted during the present year, as the available funds are barely sufficient to provide for the stone to be furnished under the existing contract.

At Lock No. 9 (Hoard's Rocks) the combined roller and slide valve, invented by Mr. F. M. G. Stoney, an English engineer, which was referred to in my last annual report, has been erected. There were some practical difficulties in adopting this valve to the peculiarities of the site, and there are some minor matters yet to be adjusted, but the net result has been a decided increase in the rapidity with which the lock can be emptied. When Lock No. 8 is completed and the level below No. 9 is raised so as to cover the discharging culvert at all stages, the valve will do still better, and will fully meet the expectations which led to its erection in the place of the former balanced valve. It is operated without difficulty by one man, and gives a clear opening of 35½ square feet, working under an extreme head of 12 feet.

COMMERCIAL STATISTICS.

Owing to the isolated position of the single Government lock on this river, the record of the commerce passing this point is of comparatively little value in estimating the amount of traffic which will result upon the completion of Lock No. 8, which will secure a continuous slackwater navigation from Pittsburgh to Morgantown. The attached table is compiled from the monthly reports of the lock-keeper at No. 9, and shows the actual commerce during the present unfinished state of the improvement.

WORK DURING 1883-'84.

There being no funds available, no work will be done during the present fiscal year. Operations at No. 8 will be confined to the receipt of stone from the contractors. At No. 9 one lock-keeper will attend to the wants of navigation.

ESTIMATE FOR 1884-'85.

As no funds were appropriated during the last session of Congress, I resubmit the estimate contained in my last annual report, which was as follows:

Amount (estimated) for completion of existing project.....	\$164, 000
Already appropriated	75, 000
Amount still required	89, 000
For running expenses and contingencies at Lock No. 9, Hoard's Rocks, there is needed	2, 000
Total for improving Monongahela River	91, 000

To the above it is necessary to add \$2,000 for the expenses of Lock No. 9 during the current year, which will have to be met out of the appropriation for building No. 8, as it is impossible to stop navigation by closing Lock No. 9.

The estimate for 1884-'85, is therefore \$93,000.

In this connection it is my duty to call attention to the absolute necessity of making some permanent provision for current expenses at Lock No. 9. The United States has built a dam across the Monongahela River at this point, and the only way to pass up or down is through the Government lock. Now that this lock has been built it must be kept in working order, and this cannot be done without funds to pay a lock-keeper and to make current repairs.

By the act of Congress passed August 2, 1882, the collection of tolls at Government locks is absolutely forbidden. As long as appropriations are made for other work on the Monongahela, it is possible to divert a small part to the expenses of No. 9, but any failure in the river and harbor bill, at a time when funds are exhausted, will have most serious consequences, unless some other provision is made.

I would therefore urgently recommend that the Government locks on the Monongahela be placed on the same footing as the Louisville and Portland Canal, the Des Moines Canal, and the Saint Mary's Canal; that is, that the necessary expenses of operating and maintenance be a permanent charge on the Treasury.

Money statement.

July 1, 1882, amount available	\$37, 968 97
Amount appropriated by act passed August 2, 1882	25, 000 00
	62, 968 97
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$34, 679 22
July 1, 1883, outstanding liabilities	4, 990 40
	39, 669 62
July 1, 1883, amount available	23, 299 35
Amount (estimated) required for completion of existing project	49, 000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	93, 000 00

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COMMERCIAL STATISTICS.

Commerce passing Lock No. 9, Monongahela River, during the fiscal year ending June 30, 1883.

Month.	Going up.						Going down.						
	Lockage.	Steamboats.	Barges and flats.	Miscellaneous.	Merchandise.	Steamboats.	Barges and flats.	Boat bottoms	Rafts.	Miscellaneous.	Merchandise.	Lumber.	Timber.
1882.					Tons.						Tons.	Fl. B. M.	Cu. ft.
July	40	10	4	2	73	10	4	...	13	68	4	24,000	26,000
August	36	4	6	2	116	4	4	...	17	1	6	141,500	43,100
September	31	4	5	2	105	4	4	...	11	4	8½		55,500
October	10		2		64	1	3				23		
November	10	1	5		72	1	5				4½		
December	7	3	2		41	2	1						
1883.													
January	1								1	1		2,200	
February	42	14		2	68½	16			10		4½	49,500	20,000
March	32	14		1	36½	15				50	3		
April	155	24	1	2	103	24	6	2	138	19½	8	653,000	366,500
May	45	10	3	3	66	10	2	1	12	94	8	8,000	37,500
June	51	9	4	2	85	9	5	2	37	452	1	230,000	68,000
Total.....	400	93	32	16	830	96	34	6	239	861	70½	1,108,200	617,200

The following statistics are taken from the last annual report of the Monongahela Navigation Company, and show the commercial movement on the lower (northern) end of the river:

SHIPMENTS ON THE MONONGAHELA SLACKWATER IN 1882.

Brick	number	1,318,175
Cattle and horses	do.	528
Cinder	tons	6,700
Classified freight	pounds	42,033,389
Coal, coke, and slack	bushels	106,168,300
Fire-clay	tons	4,737
Iron ore	do.	23,488
Iron, in pigs	do.	1,132
Lumber	feet	8,011,966
Oil	barrels	1,727
Posts	number	17,983
Posts, pit	do.	307,320
Railroad ties	do.	182,700
Sand	bushels	541,000
Sheep and hogs	number	10,958
Staves	do.	120,000
Steel rails	tons	26,308
Stone	perches	12,804
Timber	feet	3,622,567
Whisky	barrels	4,443
Passengers	number	52,226

Z 4.

IMPROVEMENT OF ALLEGHENY RIVER, PENNSYLVANIA.

The work of improvement on this river remained, as during the previous season, under the local charge of Mr. I. V. Hoag, jr., assistant engineer.

Work was limited to small repairs at the Nicholson and Six-Mile

dams, and to the removal of rocks and snags from the bed and banks of the river.

Rock obstructions are larger and more numerous in the Allegheny River than in any other that is now or has ever been under my official charge.

The season's work was restricted to that part of the Allegheny lying below French Creek. From this section there were removed 28,513 cubic yards of rock and three hundred and one snags. For details and such commercial statistics as could be obtained, reference is made to the annexed report of the assistant engineer.

As the funds previously appropriated have been expended, there will be no work done on the Allegheny during the present fiscal year.

ESTIMATE FOR 1884-'85.

The chief work to be done on the Allegheny at present is the removal of rocks, of which there is a plentiful supply on the banks and in the bed of the river. A detailed estimate cannot well be made, owing to the fact that the work will be scattered over so great a distance. One hundred thousand dollars could be used to great advantage.

The most important improvement that can be made in this river is to build a lock and dam below Herr's Island. Such a work, in connection with the Davis Island Dam, would complete the harbor of Pittsburgh and would secure throughout its limits the cheap transfer of coal, coke, ore, petroleum, pig and manufactured iron, and all other bulky articles, to the great advantage of the manufacturer and ultimately of the consumer. I therefore renew the approximate estimate of \$153,000 for the proposed lock and dam which was originally presented in my annual report for 1880, making the total estimate for 1884-'85 as follows :

For continuing the removal of rocks.....	\$100,000
For lock and dam in Pittsburgh Harbor	153,000
Total	253,000

Money statement.

July 1, 1882, amount available	\$1,899 28
Amount appropriated by act passed August 2, 1882	15,000 00
	<hr/> 16,899 28
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	16,082 59
	<hr/> 816 69
July 1, 1883, amount available.....	816 69
Amount that can be profitably expended in fiscal year ending June 30, 1885.	253,000 00

REPORT OF MR. I. V. HOAG, JR., ASSISTANT ENGINEER.

CINCINNATI, OHIO, June 30, 1883.

The appropriation of \$15,000 for this river, contained in the river and harbor act of August 2, 1882, was expended in accordance with the project submitted to the Chief of Engineers July 27, and approved by Department letter of August 2, 1882.

This project contemplated the removal of obstructions, chiefly rocks, from the shoals and prominent shore bars. In addition to this work it was, however, found necessary to take some steps to arrest the scour which had taken place below the dams at Six-Mile and Nicholson islands. The damage in each case was due to a washout on the lower side of the dam, which threatened to undermine the work.

1552 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

These dams were placed in complete repair at the following expense, viz:

Six-Mile Island:	
287 cubic yards stone, at 70 cents	\$200 90
Nicholson Island:	
4,504 feet B. M. oak, at \$25 per M	\$112 60
138 cubic yards stone, at 75 cents	103 50
432 cubic yards stone, at \$1	432 00
Total	648 10

The rock obstructions which were removed consisted, in many instances, of huge fragments which originally fell into the river from the hillsides, and were afterwards moved about by ice-gorges.

The organization and equipment of the various parties employed was the same as during the previous season.

The following is a statement of the work done at each locality:

Miles from mouth of river.	Place.	Rock removed.	Snags removed.	Remarks.
		Cu. yds.		
119	East Sandy Ripple	409		Party No. 1, J. R. Patterson, foreman.
116	Robert's Run Ripple	502		
115	Falling Spring Ripple	2,051		
102	Craig's Ripple	661		
100	Rockland Bar	2,651		Party No. 2, Frank Patterson, foreman.
88	Emblenton Bend	264	4	
86	Richie's Run Bar and Ripple	2,467		
86½	On point bar opposite	1,564		
84	Furnace Creek Bar and Ripple	2,050		Party No. 3, F. M. Campbell, foreman.
83	Clarion River Ripple	484		
82	Parker's Falls	1,290		
74	Truby's Ripple	284		
73	Sugar Creek Ripple	510		Party No. 4, H. Crawford, foreman.
71	Catfish Ripple	1,102	1	
61	Rimerton Bar	1,073		
50	Nellie's Ripple	142		
58	Rattlesnake Run Bar	564		Party No. 5, D. G. Fry, foreman.
56	Mahoning Bar	2,075		
55	Ferry Bar	97		
54	Templeton Bar	509		
53½	Ore Hill Islands	341		Party No. 6, J. M. Hudson, foreman.
53	Nigger Hole	112	8	
51½	Allegheny Furnace Landing	40		
51	Tarr's Bar	105		
50½	Barton House Landing	46		Party No. 7, Thomas Carr, foreman.
49	Wilkins Landing	202		
48½	Pine Creek Ripple	701		
48	Kittanning Ripple	389		
42	Cogley's Ripple	1,170	3	Party No. 8, J. M. Hudson, foreman.
40	Green's Bars	15		
36½	Nicholson Ripple	1		
35	Pearce Eddy	220		
31	Coyle's Run Ripple	80	1	Party No. 9, J. M. Hudson, foreman.
31½	Walkers Bar		1	
31	Sugar Loaf Bend	165	5	
32	Murphy's Island	1,262	272	
31	Sugar Loaf Bend	638	9	Party No. 10, J. M. Hudson, foreman.
30	Dock Ripple	485		
28	McKane's Bars	1,562	6	
1½	Old Aqueduct Piers			
	Pittsburgh Harbor	350		Party No. 11, Thomas Carr, foreman.
	Opposite Thirty-first street		1	
	Total	28,513	301	

The result of this work has been to increase the navigable depth in low water at the points named from 6 to 15 inches, besides lessening the hazards of navigation at higher stages.

Grateful acknowledgments for what has been done by the Government in the amelioration of navigation upon this river have been volunteered by Capt. J. H. Moore, of the steamer Modoc, the G. W. Wilkins Mills at Pine Creek, the Kittanning Rolling

Mill and Furnace Company of Kittanning, the Graham and Farmerie Mills of Etna, and many others on the river and its tributaries.

The work has also the unqualified approval of the numerous flat-boatmen who depend entirely on the navigation of this stream for a livelihood.

Operations have been confined to the section of river embraced between French Creek and the mouth, a distance of about 126 miles. Application was made to have the work extended above French Creek, but it was decided by you that under the appropriation act the funds had to be expended below French Creek. In the event of future appropriations to continue these operations I would suggest that this provision be removed, and that work be allowed wherever needed, or, at least, that it be authorized as far up as the mouth of Tionesta Creek, which point is about 150 miles from the mouth of the river.

The attempt has been made to thoroughly complete the work as it advanced, and it is believed that these efforts have met with a gratifying success, and the places worked over are probably not susceptible of better improvement without slack-water. Between the mouth of the river and Tionesta Creek the extent of river thus far cleared will embrace about one-half of the necessary work, and a much larger sum than any of the past appropriations could be advantageously expended during any low-water season, a period usually of about three month's duration. The removal of these obstructions would afford increased safety and also extend the navigable depth sufficiently to permit of constant traffic by the class of boats now employed, as well as to prolong the duration of navigation for rafts and other descending craft.

RESOURCES OF THE ALLEGHENY RIVER.

Extensive deposits of iron ore, coal, fire-clay, limestone, and sand abound in the hills of this valley, and the lumber trade, for which it has been chiefly noted, is confined to the product of the tributary streams. The principal of these tributaries are Tionesta and French creeks, and Clarion, Red Bank, and Mahoning rivers, all of which, with the single exception of French Creek, enter the Allegheny from the left or east bank.

The commerce of the Tionesta and Clarion consists almost entirely of timber products; such as rough and dressed lumber, laths, shingles, bark, boat bottoms, and coal barges.

In addition to the above there is also produced on the Red Bank a superior quality of fire-clay, which is said to rival the finest ever discovered, besides iron ore and pig-iron, which are all large and growing industries.

The Tionesta lumber mills have a capacity of 100,000,000 feet B. M. per annum, and there is annually cut and floated down the river over 43,000,000 feet B. M. of timber alone.

On the Clarion, the mills have a capacity of over 125,000,000 feet B. M. and the annual product floated to market is 25,000,000 feet of boards, 30,000,000 feet B. M. of logs, 5,000,000 shingles, and 1,000,000 laths, besides from 500 to 1,000 boat bottoms designed for the coal trade of Pittsburgh.

The mills of the Red Bank ship over 20,000,000 feet B. M. of dressed lumber annually by rail, for want of cheaper facilities, and, during seasons of freshets, the amount annually floated down the river will equal that of the Clarion.

On the Mahoning, also, much timber is cut and sent down by river, but the industry is not as settled as on the other streams.

On the Allegheny proper the present industries embrace active operations in all of the minerals herein named. These operations are, however, but a tithe of what they would be with proper water facilities.

The general commerce of the Allegheny is of an irregular character, and no public record of its traffic is anywhere kept, and it would require a personal effort, consuming weeks of time, to arrive at a proper estimate of the gross amount of trade. It was not practicable for me to afford this time, and I am able, therefore, to present but a part of these statistics, which have been collected by Mr. W. P. Younger, inspector, as his other duties would permit. His investigations cover the portion of the river between Mahoning and Freeport, a distance of 28 miles.

"Mahoning, 65 miles above Pittsburgh.—November 9, 1882, commenced investigations 2 miles up the river, at the furnace of Laughlin & Co., which is running full blast. No fuel is used but gas obtained from a well, which the furnace company put down one-fourth of a mile from their works. Mr. Laughlin showed me the different strata of iron ore, limestone, coal, and fire-clay.

"There are four different veins of coal, varying in thickness from 2 to 5 feet.

"The 5-foot or lower vein is 60 feet below the bed of the river. It was discovered when boring the gas well. There are two 2-foot veins, which are not worked. The top or 4-foot vein is used for making coke, besides supplying fuel for local consumption. The coke produced is said to be of an excellent quality.

"The limestone vein is 12 feet in thickness, and is used in large quantities at the

furnace. There is also an unlimited supply of iron ore, which yields from 25 to 50 per cent., or an average of 40 per cent. of good iron.

"The fire-clay is not worked, as there is no demand for it at the furnace.

"All the minerals here mentioned are said to run the whole length of the river.

"The quantity of ore used at the furnace this year is 14,000 tons, and of limestone about 7,000 tons; also a large quantity of sand, which is abundant and of a superior quality, for fluxing purposes.

"The iron produced amounts to about 4,000 tons annually. This product is hauled 2 miles by wagon to the nearest railroad point, and is thence shipped to the Pittsburgh markets.

"With a proper improvement of the river this production would be immensely increased, and at a very much reduced cost.

"The timber in the valley is composed of oak, hemlock, and pine. It is transported to market by water during freshets. I could not get the amount annually out, as no one could give me an approximately correct statement of that trade.

"There is another furnace in successful operation 7 miles further up this river. It is known as the Caldwell furnace. The entire product is stored until high water, at which time it is shipped in boats to the Pittsburgh markets.

"*Templeton, 1 mile below Mahoning.*—Thirty tons of iron ore is mined and shipped daily from this point.

"*Pine Creek saw-mill, 4 miles below last point.*—Mr. G. W. Wilkins, the proprietor of these mills, makes the following statement of the year's business:

Lumber built into barges.....	feet B. M..	2, 150, 000
Lumber shipped on barges.....	do...	1, 000, 000
Shipped on barges.....	laths..	600, 000
Shipped on barges.....	coal-pit posts..	25, 000

"The mills have a capacity of 3,000,000 feet B. M. lumber per annum, and an increase of 1,000,000 feet is expected during 1883. In addition, 1,000,000 feet B. M. lumber will be bought to be made into boxes, which will be shipped by rail.

"Mr. Wilkins states that he has derived great benefit from the improvement of the river, as barges can now be run at any time when the river is not closed by ice. Previous to the improvement he was at times obliged to hold them two months, and then run the risk of their being caught in the ice.

"*Cowaneshannock, 48 miles above Pittsburgh.*—Messrs. H. R. and W. Skelly have recently erected a large and valuable plant at this point for the production of fire-brick, tiling, &c. Their present annual output is 1,200,000 fire-brick, besides a large amount of tiling. They also ship 25 tons of fire-clay daily. A new company has recently located here, which is making improvements for an extensive coal trade.

"*Kittanning, 45 miles above Pittsburgh,* is a thriving, solidly built town of 2,624 inhabitants. Various industries abound, although the predominating one is the works of the Kittanning Rolling Mill and Furnace Company. One hundred thousand tons of iron ore, 50,000 tons of limestone, and 1,000 tons of sand are annually consumed here, for the larger part of which they are dependent on water transportation. The manager, Mr. Charles Neal, is much pleased with the recent river improvements, which enable them to increase the draught of their boats.

"*Manorville, 2 miles below Kittanning,* is an active shipping point. About 200,000 tons of limestone and 800,000 fire-brick are annually sent from here.

"*Roseton, 2 miles below last point.*—William Bailey's limestone quarry here ships from 50 to 75 tons of stone daily by rail to the Lucy furnace at Pittsburgh. Mr. Bailey says that this production would be greatly increased if the river was better improved, so as to admit of water transportation.

"*Logansport, 31 miles above Pittsburgh.*—There are five limestone quarries in successful operation here. Loomis Brothers, who have erected a large and expensive plant, ship by rail 200 tons per day. They desire to ship entirely by river, but the facilities are entirely too uncertain, and at this time they have had 1,000 tons loaded on boats for two months, waiting for a rise of the water. Of the other quarries, Mahoffey and Snyder, both ship 100 tons daily by rail, while McCaslin and Hudson, who depend entirely on the river, ship each 50 tons daily by water.

"*Glen Coal Works, 36 miles above Pittsburgh.*—These works ship daily by rail 1,200 bushels of coal and 40 tons of limestone. They would do a large river business if the Allegheny were properly improved.

"*Kelley, 35 miles above Pittsburgh.*—This place ships 800 tons of limestone monthly.

"*Freeport, 27 miles above Pittsburgh.*—Gugenheimer's distillery, located at this point, does a very large and growing trade. They make at their cooperage here from 18,000 to 20,000 whisky barrels annually for their own use. Much of their supplies comes from Illinois and Indiana to Pittsburgh by water, and thence to this point by rail. They feel the want of proper water transportation from Pittsburgh very much.

"There is also a large barge yard and saw-mill at this point, which consumes annually 5,000,000 feet B. M. of timber for general purposes, and 1,000,000 feet B. M.

used in constructing barges. They are dependent on the river for supplies and greatly deplore their meager water facilities."

Notwithstanding the great importance and wealth of the Allegheny River and Valley, no attempt has ever been made, until within two or three years, to aid or develop the navigation of this stream, although I am credibly informed that more than forty years ago a project for its radical improvement by locks and dams was strongly supported.

That project was accidentally defeated by a strange misunderstanding of the then dominating lumber shippers, who regarded dams as inimical to their interests, and solely from this cause, so states General J. K. Moorhead, formerly member of Congress, the capital seeking investment was diverted to the Monongahela Valley, with the striking result, there presented to-day, of the most prosperous valley in the United States, wholly dependent for that prosperity on its water privileges.

The city of Pittsburgh, as a manufacturing center, undoubtedly owes very much of its prominence and prosperity to the slack water of the Monongahela River, and for these reasons I would strongly urge the manifest advantage and utility of extending similar facilities to the Allegheny Valley.

The first consideration in any enterprise should be an end commensurate with the expense. I do not believe that it will require much argument to show that a lock and dam located at the head of the pool of the Davis Island Dam, or below Garrison Ripple, with a 12-foot lift, sufficient to drown out Garrison, Six Mile, and Nine Mile ripples, thus extending the benefits of a constant navigable depth almost to the soda works, will justify the expense. Such an improvement will present more than 25 miles of additional valuable water front, with an immense number of desirable sites for mills or other industrial establishments, besides affording relief and a new outlet to the many extensive works now located on the banks of this river, many of which languish for want of better water facilities. Messrs. Graham and Farmerie, extensive saw-mill and lumber men and boat builders, whose mills are located above Garrison Ripple, inform me that they annually lose thousands of dollars for want of a proper improvement of the river.

Messrs. Walter and Darragh, mill owners of Sharpsburg, also make similar complaint, and, besides the above, some of the largest blast furnaces and iron mills in the country, employing a capital of millions of dollars, are located on this part of the river, and depend largely for fuel and other shipping facilities on it.

Garrison Ripple is within the corporate limits of the city of Pittsburgh, and less than 3 miles from the mouth of the river. It is the greatest obstruction on the river, and no system of improvement is complete without embracing it. It is not susceptible of any further improvement except by lock and dam. In a previous report you have submitted estimates for the construction of such a work, and I beg to renew the recommendation that it receive early attention.

Respectfully submitted.

I. V. HOAG, JR.,
Assistant Engineer.

Lieut. Col. W. E. MERRILL,
Corps of Engineers.

Z 5.

ICE HARBOR AT MOUTH OF MUSKINGUM RIVER, OHIO.

As heretofore, this work has been under the local charge of Mr. William Weston, assistant engineer. Active operations for continuing the construction of the lock at Marietta were resumed on August 3, the project being to construct an inshore coffer-dam, and to complete the land wall and bank protection to some point below the line of the State dam. In the afternoon of this day (August 3), however, a break occurred in the State dam just outside of the Government coffer-dam, which drained the pool and seriously injured the coffer. High water prevented work until August 10, when the new condition of affairs rendered a change of project advisable; it was then determined, with the approval of the Chief of Engineers, to expend the season's work in prolonging the outer wall of the lock.

A coffer-dam was built which extended 129 feet below the crest of

the State dam, and continued thence 100 feet to the shore. For a portion of this distance the depth at low water was upward of 20 feet, the bottom being of rock covered with about 2 feet of gravel. This thickness of gravel was insufficient to hold the piling for the coffer, and tie rods had to be inserted to prevent the walls from spreading. The inclosure was ready for pumping on September 20, but a rise in the Ohio River delayed the work so that it could not be emptied until October 5.

Owing to the lateness of the season, it was thought unsafe to tear away any part of the State dam, and the work was therefore limited to extending the outer wall of the lock to the upper face of this dam, and to getting in another portion of the foundation of the upper half of the lock chamber.

On October 4 masons were set to work to finish the upper section of the outer lock wall, which was built up last season to 12 feet above the lock floor; this work was finished on October 19, and the wall was afterwards pointed. Masonry on the new section of the river wall, 68 feet in length, and extending down to within 12 feet of the dam, was begun on November 7, and was finished, except the coping, on the 28th of the same month.

One hundred and seventeen piles were driven for the foundation of the lock above the dam. Thirty piles were also driven in the lower coffer, but, owing to the fact that some of the piles struck rock so near the surface as to make it questionable whether piling should be used for foundation in this part of the lock, it was thought best to make extended borings over the doubtful area before deciding on the character of the foundation, and the driving of piles was accordingly suspended. A few borings were made, but high water stopped operations before sufficient information as to the lay of the bed rock had been obtained.

The upper gates of the lock were completed and they were put in place, with all necessary apparatus for handling on December 6.

After repairing and strengthening the coffer dam and the State dam inside the lock, to enable them to withstand the floods and ice of winter, the working force was discharged and active operations for the season was closed on December 22.

The amount of permanent work accomplished during the season is as follows:

Excavation	cubic yards..	2, 600
Piles driven		117
Lock floor laid	square feet..	1, 350
Concrete laid	cubic yards..	147
Masonry laid	do.....	952
Lock gates hung		2

The contractor for furnishing stone for this lock (T. B. Townsend, contract February 16, 1880), completed his contract on November 11, having delivered 5,050.45 cubic yards of dimension and 6,149.52 cubic yards of rubble stone, at a total cost to the United States of \$28,465.75. The stone are to be dressed by the United States.

The contract of W. H. Ewing & Co., dated March 24, 1882, for furnishing square piles and lock-gate timber was completed on October 7. The contract of Stephen G. Sprague for furnishing round piles was unfinished at the close of the year, but has since been closed.

WORK DURING 1883-'84.

No work will be attempted during the present year for lack of available funds.

ESTIMATE FOR 1884-'85.

Owing to the small appropriations hitherto made to the increased cost due to the necessity of waiting until half of the working season was ended before beginning work, thus being constantly forced to restore temporary structures which could have been removed or abandoned had the work progressed at a reasonable rate, to the damage caused by the break of the State dam, and to the loss that must accrue during the total cessation of work for a year, while the second coffer-dam is exposed to possible destruction by floods and ice, it will be necessary to add at least \$30,000 to the revised estimate of the cost of the work.

I have therefore to submit for the next season an estimate of \$96,400. It is also my duty to state that if the work is compelled to drag on as heretofore with insufficient appropriations, it will be impossible to make any reliable estimate of its ultimate cost.

Money statement.

July 1, 1882, amount available	\$7,254 62
Amount appropriated by act passed August 2, 1882	40,000 00
	<hr/> 47,254 62
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$38,659 97
July 1, 1883, outstanding liabilities	638 69
	<hr/> 39,337 66
July 1, 1883, amount available	7,916 96
	<hr/> 96,400 00
Amount (estimated) required for completion of existing project	96,400 00
Amount that can be profitably expended in fiscal year ending June 30, 1885 ..	96,400 00

Z 6.

HARBOR OF REFUGE NEAR CINCINNATI.

The work thus far completed under appropriations for a harbor of refuge near Cincinnati consists of two dikes in the Ohio River at Four-Mile Bar, 10 miles above Cincinnati, designed primarily to catch and hold back ice-floes, which might otherwise lodge in the harbor of Cincinnati; and secondarily to improve navigation at Four-Mile, which has hitherto been one of the shoalest bars above Cincinnati.

After these two dikes had been built it was decided that the desired effect would not be fully obtained without a third dike on the Ohio side, and estimates for such a dike were duly submitted, amounting to \$33,000. The river and harbor act of August 2, 1882, appropriated \$16,000 for this work, but as this was not quite half of the sum required, the Chief of Engineers approved my recommendation that no work be begun until the whole amount needed had been appropriated.

I have therefore to report that no work was done during the past fiscal year, and that no work is contemplated during the present fiscal year. I also renew my former estimate of \$17,000 for the completion of this project.

Money statement.

July 1, 1882, amount available	\$16,000 00
July 1, 1883, amount available	16,000 00
Amount (estimated) required for completion of existing project	17,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885 ..	17,000 00

APPENDIX A A.

IMPROVEMENT OF KENTUCKY AND TIDEWATER RIVERS OF BIG SANDY RIVER, KENTUCKY AND WEST VIRGINIA, AND OF GUYANDOTTE AND LITTLE KANAWHA RIVERS, WEST VIRGINIA.

REPORT OF CAPTAIN JAMES C. POST, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|---|---|
| 1. Kentucky River, Kentucky. | 3. Guyandotte River, West Virginia. |
| 2. Big Sandy River, West Virginia and Kentucky. | 4. Little Kanawha River, West Virginia. |
| | 5. Tradewater River, Kentucky. |
-

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, July 28, 1883.

GENERAL: I transmit herewith the annual reports for the fiscal year ending June 30, 1883, for the several works of improvement under my charge.

I assumed charge May 1, 1883, relieving Lieut. Col. William E. Merrill, Corps of Engineers, who had temporary charge of the district during the sickness and after the death of Maj. James W. Cuyler, Corps of Engineers, April 16, 1883.

Very respectfully, your obedient servant,

JAS. C. POST,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

A A 1.

IMPROVEMENT OF KENTUCKY RIVER, KENTUCKY.

At the close of the last fiscal year the slack-water system on this river was in successful operation for 82 miles, or as far as it was influenced by the repair and reconstruction of the first four locks and dams.

These works were far from being complete at that time, and much remained to be done to put them in a safe and secure condition.

The operations during the past year have been conducted with a view of establishing the permanency of this improvement, and navigation has been continued with only an interruption of a few days, except that caused by the freshets which have been unprecedented in height during the past winter.

The following is a summary of the work done at the different locks as contained in a report of Assistant Engineer D. L. Sublett, at present in local supervision of these works.

LOCK NUMBER 5.

Old gates removed and Government grounds inclosed.

LOCK NUMBER 4

Guard cribs were built and filled with stone, old dam temporarily repaired, and stone filling replaced that had been washed out; a cross rubble wall was built at lower end of the lock, and a stone retaining wall for the bank. Lock-house was put in temporary repair and the United States Government grounds on the lock side inclosed.

LOCK NUMBER 3.

Guard cribs raised and lower river crib lengthened. The lower end of the stone abutment was also raised, the lock-house was repaired, a cistern built, and the Government grounds ditched and drained.

LOCK NUMBER 2.

The dam at this place, which was left in an uncompleted condition the previous season and had sustained some damage from the winter and spring rises, was completed, as was also the crib abutment and the guard cribs. The dam was backed with clay and gravel.

In order that navigation might not be interrupted during the progress of the work, a movable bridge was erected over the lock wall to facilitate putting in stone filling at a cost of about \$1,000.

LOCK AND DAM NO. 1.

The end of the fiscal year 1881 and 1882 found the breach or "cut-off" around the dam which occurred in October, 1881, practically closed so far as securing navigation was concerned, being at this date some 5 feet above the crown of the dam. The record of previous "run-outs" or local rises at this lock showed there had been instances of from 10 feet to 15 feet rises in twenty-four hours, with a fall of from 6 to 15 feet, dependent on the condition of the Ohio. It therefore became imperative, in order to secure this work, that it should be raised from 14 feet to 16 feet above the crown of the dam to prevent a recurrence of the disaster. This was done by capping this work with a crib 16 feet wide and 196 feet long, filled with stone and sheeted on river side.

The dam, which was only partially completed, was sheeted both above and below for half its length.

A crib abutment was built in lieu of the stone abutment partially destroyed by the "cut-off."

From settlements and other causes the dam had to be raised in order to give the necessary 6-foot navigation at number 2, which was done. Some 675 linear of feet guard cribs were built both above and below the lock and filled with stone, and the dam backed with stone, brush, and gravel, and lock-house repaired.

A pile-driver boat was built at a cost of \$2,500, and three rows of piles driven across the gap below the dam with a view to closing this, if experience proved it to be necessary.

It soon became evident that the gap below the dam would have to be closed, as the fall over the dam during a rise in the Kentucky and the Ohio at a low stage would put in motion the large body of water lying behind the abutment, producing very strong eddies that caused serious cavings of the sandy banks, threatening another disaster from cutting back or up-stream.

This gap was therefore closed by cutting off the piles at a common level, filling between with brush and stone, and then erecting thereon crib-work to a sufficient height to prevent the reaction of the water. The banks were also matted with brush held down with stone. This work was continued from time to time as the stage of water would permit, and was completed in May last.

The importance of this work is fully demonstrated from the fact that the banks have ceased to cave, and there has been a filling in behind the abutment since this work began of 15 feet, and a total fill of 25 feet, and the whole area is now dry at low water.

In addition to the above, a survey has been made for the location of a lock and movable dam at Beattyville, Ky., at the junction of the Three Forks, 170 miles above the limit of the present slack-water navi-

gation. A site has been selected, but in the absence of the authority of Congress to make the necessary purchase of land, nothing beyond the discussion of a suitable design for this dam has been undertaken. This has developed a problem containing many difficulties. The conditions require a dam with a lift of not less than 12 feet, and to make this a movable one requires the construction of the most expensive form known. With movable dams generally the leakage is very great, and it is exceedingly doubtful whether the water supply at this point during the dry season when the dam is most needed will be found sufficient to keep the pool up, if such a structure is built. It is recommended that when Congress authorizes the purchase of the land necessary for the construction of this work, that it should provide also for the reference of this subject to a Board of Engineers for general discussion. The question to be determined is, whether a movable dam, or a permanent one, with one or more chutes, is best suited to the interests of navigation at this place. It may also be questioned whether a lock is necessary at the present time. It is estimated that a lock of the required size would cost \$100,000, and that a suitable movable dam would cost \$125,000 in addition, making \$225,000 in all. A fixed dam with a lift of 12 feet and with two passes or chutes, each 60 feet wide, fitted with chanoine wickets, can be constructed, it is estimated, for \$92,500.

The act of Congress passed August 2, 1882, appropriated \$225,000 for the improvement of this river, and provided that \$75,000 of this amount should "be used for the erection of a lock and movable dam at Beattyville." Of this latter \$2,185.26 have been expended, leaving a balance still available of \$72,814.74. An additional appropriation of \$19,685.24 is required to complete this work, according to the smallest estimate made—that for a permanent dam, with passes or chutes.

The navigation of the Kentucky River is at present greatly restricted by the existence of the bridges crossing it. There are three of these; one at Worthville, 11 miles from its mouth, and two at Frankfort, 65 miles from the mouth. The former and one of the latter are iron structures, belonging to the Louisville and Nashville Railroad, and are unprovided with draws. A rise of 6 feet in this river, which is not infrequent, prevents the steamers from going above the railroad company's bridge at Frankfort, and if this is accompanied by a rise in the Ohio, even of moderate dimensions, navigation by steamer is entirely suspended, on account of the impossibility of passing the bridge at Worthville. The second bridge at Frankfort, and which belongs to the city, is also unprovided with a draw. It is 2 feet lower than the railroad bridge, and prevents the river steamers from passing above the city, except at extreme low water. This question is a very serious one in connection with the improvement of this river, and Congress is especially requested to take some action in regard to it. Another bridge across the river is contemplated at Tyrone, 17 miles above Frankfort, and others are not unlikely to be constructed. It would therefore seem necessary, if navigation is to be continued, that some general law be enacted in regard to bridging this river, similar to that passed affecting the Ohio River, by which the height and span of all bridges may be made subject to the demands of commerce. This law should also require those already constructed to be modified, with draws or otherwise, so that the steamers may pass unhindered.

A complete revision of the estimates for the extension of slackwater navigation on this river to Beattyville, at the junction of the Three Forks, shows that those submitted in the report of January 14, 1879, were much too small. This project contemplated the construction of

twelve locks and dams, and the repair of the five locks and dams then in the river.

The engineering difficulties encountered in this work have been far greater than were at first anticipated, and up to the present time but four of the five locks and dams have been put in operation. Even these still require considerable work upon them before they can be regarded as completed.

The following is the revised estimate for this project:

Twelve new locks and dams.....	\$2,400,000 00
Repairs to fifth lock and dam now in the river.....	112,020 00
Repairs to the other four locks and dams	67,391 29
Total.....	2,579,411 29
Balance on hand.....	107,772 03
Required to complete existing project.....	2,471,639 26

This estimate is believed to be accurate, and is based upon the experience already gained in contending with the difficulties encountered in the construction of lock and dams in this river, and upon a survey for the location of the site for the first of the twelve new locks. The large cost of the repairs to the fifth dam and lock is due to the extensive work required. The dam and abutment must be rebuilt entirely, and a large breach around the abutment site closed, as well as the lock repaired.

Under the present arrangement for the navigation of this river, its continuance depends entirely upon the yearly appropriations made by Congress. Should these fail at any time there is no provision for the payment of the lock-keepers and for making such repairs as will always be necessary from time to time. After the locks and dams are once completed the amount required for their superintendence, repairs, &c., will be comparatively small, but if there is no fund from which these can be paid navigation must cease and the works allowed to deteriorate. I therefore renew the recommendation of my predecessor (the late Maj. J. W. Cuyler, Corps of Engineers), that the Kentucky River be placed upon the same conditions as the Des Moines Rapids Canal, the Saint Mary's Canal, and the Louisville and Portland Canal, in regard to allowing the cost of maintenance and repairs of the locks and dams to be paid directly from the Treasury, upon the proper requisition, without a specific appropriation being made. With the work needed upon these locks and dams now in operation, the present amount available cannot be expected to keep them in operation for a longer time than during the next fiscal year, and only for this period, provided but little damage is done to them during the coming season. At present Dam No. 4 requires extensive repairs before it can be considered safe, and these will be undertaken this season.

The breach at No. 1, though closed, is not unlikely to give further trouble, and will continue to endanger navigation so long as there is a large open space behind the closing works into which the water flows. This is now gradually filling up, and there is every reason to believe it will become completely so, if Congress provides the means to take proper care of it.

The operations for the coming year will consist of repairing the four locks and dams now in operation, and lock and dam No. 5. The construction of lock and dam No. 6, and the lock and dam at Beattyville, will also be commenced, provided Congress authorizes the purchase of the necessary land for the sites of these works, and a sufficient appropriation is made.

The following amounts have been appropriated since this project has been commenced:

By act of Congress March 3, 1879.....	\$100,000
By act of Congress June 14, 1880.....	100,000
By act of Congress March 3, 1881.....	125,000
By act of Congress August 2, 1882.....	225,000
Total	550,000

The amount expended up to June 30, 1883, including outstanding liabilities, is \$442,227.97.

The following papers accompany this report:

1. A drawing showing the condition of the breach at No. 1.
2. Partial statistics of the amount of commerce on the Kentucky River.
3. Table of lockages at Locks Nos. 1 and 2.
4. Commercial statistics of Beattyville and vicinity.

Money statement.

July 1, 1882, amount available.....	\$1 24
Amount appropriated by act passed August 2, 1882.....	225,000 00
	<hr/> 225,001 24
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$116,191 51
July 1, 1883, outstanding liabilities.....	1,037 70
	<hr/> 117,229 21
July 1, 1883, amount available.....	107,772 03
	<hr/> 2,471,639 26
Amount (estimated) required for completion of existing project.....	2,471,639 26
Amount that can be profitably expended in fiscal year ending June 30, 1885.....	380,000 00

COMMERCIAL STATISTICS.

Report of commerce on the Kentucky River for the six months ending June 30, 1883.

Articles.	Steamers.						Rafts.	Total.
	City of Frankfort.	Fannie Freese.	Dora Number 2.	Alex. Montgomery.	R. J. Grace.	B. F. Devel.		
Timber..... cubic feet.							2,472,000	2,472,000
Lumber..... M feet B. M.	120	40						160,000
Flour..... barrels	3,336	1,033	52					4,421
Whisky..... do.	1,722	81	7,480					9,283
Molasses..... do.	243							243
Lime and cement..... do.	2,948	1,833						4,780
Salt..... do.	1,895							1,895
Wheat..... sacks	10,748	5,059	1,995					17,802
Seeds..... do.	538	319						847
Corn..... do.	26,378	4,000	3,422					33,790
Hay..... bales	1,697	1,639						3,336
Tobacco..... hogsheads	1,596	890	68					2,555
Staves and shingles..... M.	282	21						303,000
Coal..... tons	450	340	640	6,000	880	100		8,410
Merchandise..... do.	450	666	75					1,191
Merchandise..... packages	12,935		150					13,085
Furniture..... do.	1,057							1,057
Passengers.....	1,690	970	99					2,719
Sheep, hogs, and cattle.....	800	92	605					1,497

* 2,092,000 stopped above No. 4 at Frankfort.

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The report of the steamers City of Frankfort, Fannie Freese, and B. F. Deval is only partial. No reports have been obtained from the steamers Hornet, Little Harry, Colonel Sellers, and J. M. Abbott, all of which are engaged in the commerce of this river.

Navigation statistics for the fiscal year ending June 30, 1883.

Locks.	Steamboats.	Barges.	Rafts.	Flat-boats.	Skiffs.	Total number of lockages.
Lock No. 1	442	209	130	23	119	923
Lock No. 2	385	68	139	3	68	663
Lock No. 3						
Lock No. 4						

A complete record of the lockages at Nos. 3 and 4 has not been kept.

Amount of yearly commerce passing down the Kentucky River from Beattyville and above, and the average percentage of losses incurred by the present system of navigation.

Articles.	Quantity.	Market value.	Lost.		
			Percent- age.	Quantity.	Value.
Coal	650,000 bushels	\$81,250 00	10	65,000	\$8,125
Saw-logs	6,000,000 feet B. M.	50,000 00	5	3,000,000	25,000
Railroad ties	5,000	27,500 00	2	1,100	550
Total value		608,750 00			33,675

A A 2.

IMPROVEMENT OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

During the past year operations have been continued upon the improvement of the Tug and Louisa forks. The work of improving navigation through the Roughs of Tug, 96 miles above Louisa, Ky., commenced last year, was completed by the removal of rocks and the construction of chutes, 15 to 20 feet wide, over seven shoals. Between the foot of the Roughs and the junction with the Louisa Fork various rocks were removed and chutes constructed. The improvement of the Louisa Fork was extended to 100 miles above Louisa, and 15 miles above the head of steamboat navigation at Piketon, Ky. Over this distance snags, stumps, and rocks were removed and chutes built across shoals. Some work that was necessary was also done on the main river below Louisa. An examination was also made of the Louisa Fork from Piketon, Ky., to Grundy Court-House, Va., a distance of 52 miles, with an estimate of the cost of rendering it navigable for light-draught freight boats and rafts at an average stage of water. This is stated to be \$200 per mile, or \$10,440 for the entire distance. In the absence of any statistics as to the commerce of this locality seeking an outlet, it is impossible to make a statement of the importance of this work. For the details of the work done I refer to the report of Mr. E. A. Chase, assistant engineer, in local charge, herewith inclosed.

The following is a summary of what has been accomplished upon these streams since work had been commenced:

By the removal of obstructions and the formation of chutes a ea channel has been formed, which, at an ordinary stage of water, is 50 feet wide and about 2 feet deep. This extends from Louisa, Ky., up the Louisa Fork a distance of 100 miles, and 15 miles above Piketon, Ky., the head of steamboat navigation. A similar channel has been formed in the Tug Fork for a distance of 108 miles.

The character of the work done, and that of the country through which this river and its forks pass, is such that the improvement made cannot be of a permanent nature. The banks are sandy, full of rocks, and the changes in the river, caused from time to time by freshets and sudden rises, are constantly developing new obstacles to navigation. Trees are washed from the banks, forming new snags, and rocks are rolled into the channel. The chutes formed across the shoals also constantly need attention to prevent them from being filled up by the large amount of sand swept from the banks. These conditions show the necessity of yearly appropriations for these rivers, if the present improved channels are to be kept open. Now that they are fairly established, the amount required to maintain them will not be large. The \$5,000 provided for the improvement of the Tug Fork by the act of Congress of August 2, 1882, was expended during the past year's operations. A small balance remains of the \$5,000 appropriated for the improvement of the Louisa Fork, and a party is at present in the field clearing the stream of a few obstructions near Piketon, Ky., which have recently developed.

An appropriation of \$5,000 is recommended for this river and its forks, for the next fiscal year, to be applied upon the main river or upon either or both of its forks as the interests of commerce may demand. This amount will enable the present channel to be maintained and make some repairs that are needed to the chutes on the forks which were constructed by the State of Kentucky some years ago.

The plan and specifications for the lock to be constructed at Louisa, Ky., having been completed, bids were invited September 25, 1882, for the delivery of the stone necessary for its construction. As they all greatly exceeded the original estimate for the cost of this work they were rejected. New bids were received on June 20, 1883, after the specifications had been modified somewhat. The lowest one, that of David B. Shipley, of Cincinnati, Ohio, being considered reasonable was accepted. The original estimate for this lock and dam was \$110,000. Later data obtained by making borings from changes that have taken place in the river banks and bed and the advance of the price of labor increases this estimates to \$213,237.39, as follows:

ESTIMATE OF COST OF LOCK.

11,228 cubic yards of stone	\$69,541 75
Labor and materials required for laying same	44,912 00
2 upper and 2 lower gates.....	6,000 00
4 wickets	700 00
Coffer-dam.....	10,945 00
7,750 cubic yards sand from interior of coffer, at 25 cents	1,937 50
2,160 cubic yards rock excavation for lock walls, at \$2.....	4,320 00
House for lock-keeper	1,800 00
Adjustable dam at head of lock.....	306 00
	<hr/>
	140,462 25
Engineering and contingencies, 10 per cent	14,046 22
	<hr/>
	154,508 47

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ESTIMATE FOR TIMBER DAM.

177 cubic feet lumber 12 by 12", at 25 cents per cubic foot.....	\$44 25
Cross stringers, per running foot of dam, 1,800 linear feet.....	1 44
20 cubic yards riprap filling, at \$1.....	20 00
Drift-bolts and spikes.....	10 00
Piles and driving, per running foot of dam (1,200 piles).....	14 00
Labor, per running foot of dam.....	20 00

Total, per running foot 109 69

Cost of 300 running feet of dam	32,907 00
Engineering and contingencies, 10 per cent	3,290 70

36,197 70

COST OF MASONRY ABUTMENT.

1,633 cubic yards coursed rubble, at \$8.50 per cubic yard	\$13,880 00
7,079 feet, B. M., flooring, at \$30 per M (laid)	212 94
14,310 feet, B. M., caps and stringers, at \$30 per M	429 30
156 piles, driven, at \$3.50 per pile.....	546 00
9,333 cubic yards earth excavation, at 25 cents per cubic yard.....	2,333 30
210 running feet sheet piling, at \$3.50 per foot (driven)	735 00
666 square yards paving bank, at \$2.16 per square yard.....	1,438 56

19,575 10

Engineering and contingencies..... 1,957 51

21,532 61

TOTAL COST OF LOCK AND DAM.

Lock	\$154,508 47
Dam.....	36,197 70
Abutment.....	21,532 64
Site	998 54

213,237 39

The operations of the coming season will consist of the removal of such obstructions to navigation as may be found in the Louisa Fork of the river, which have been caused by the late freshets, and the commencement of the construction of the lock at Louisa, Ky.

The following amounts have been appropriated since these improvements have been commenced:

By act of Congress June 18, 1878.....	\$12,000
By act of Congress March 3, 1879.....	12,000
By act of Congress June 14, 1880.....	55,000
By act of Congress March 3, 1881.....	50,000
By act of Congress August 2, 1882.....	25,000

154,000

In the acts appropriating the above amounts \$43,000 was designated by Congress for the removal of obstructions to navigation in the river and its tributaries, and \$42,027.33 has been expended for this purpose. The remaining \$101,000, appropriated, was for the construction of a lock and dam at Louisa, Ky. Total amount expended to June 30, 1883, including outstanding liabilities is \$52,435.28.

Money statement.

July 1, 1882, amount available.....	\$89,204 12
Amount appropriated by act passed August 2, 1882.....	25,000 00

114,204 12

July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$12,538 90
July 1, 1883, outstanding liabilities.....	100 50
	12,639 40

July 1, 1883, amount available..... 101,564 72

Amount (estimated) required for completion of existing project.....	112,645 31
Amount that can be profitably expended in fiscal year ending June 30, 1885.	89,000 00

Abstract of proposals for stone received by Maj. James W. Cuyler, at Cincinnati, Ohio, September 25, 1882.

Bidders.	Cut stone.		3,847 cubic yards squared stone.	2,953 cubic yards backing stone.	843 cubic yards special stones.	Aggregate.
	1,856 cubic yards dressed face.	1,729 cubic yards quarry face.				
	<i>Per cu. yd.</i>	<i>Per cu. yd.</i>	<i>Per cu. yd.</i>	<i>Per cu. yd.</i>	<i>Per cu. yd.</i>	
Patriok Hart.....	\$13 00	\$10 00	\$7 00	\$4 00	\$16 00	\$38,647 00
Jones, Peters & Scully.....	12 00	11 00	9 00	4 50	14 00	101,004 50
Indians Oolite Limestone Company.....	17 00	15 11	12 95	11 85	21 00	160,191 80
Thomlinson & Reed.....	18 90	16 20	16 20	16 20	22 95	192,565 05

Abstract of proposals for stone received by Capt. James C. Post, at Cincinnati, Ohio, June 20, 1883.

Bidders.	Cut stone.		4,149 cubic yards squared stone.	2,953 cubic yards backing stone.	843 cubic yards special stone.	Aggregate.
	1,556 cubic yards dressed face.	1,729 cubic yards quarry face.				
	<i>Per cu. yd.</i>	<i>Per cu. yd.</i>	<i>Per cu. yd.</i>	<i>Per cu. yd.</i>	<i>Per cu. yd.</i>	
David B. Shipley.....	\$7 50	\$6 50	\$5 50	\$4 00	\$14 25	\$60,541 75
McMahon & Lard.....	8 50	7 50	5 50	4 25	13 50	72,932 75
John D. Shipman.....	9 00	7 50	5 50	4 00	14 00	73,394 00
Hoag & Pettitdidier.....	9 75	8 70	5 90	4 65	22 00	78,528 05
P. S. Hart.....	11 00	9 00	6 00	3 50	14 00	79,676 50
H. S. Hopkins.....	12 00	10 00	9 00	8 00	15 00	109,554 00
Thomas Rogers.....	15 00	11 25	8 75	7 50	22 50	120,192 50

REPORT OF MR. EDWIN A. CHASE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE, Cincinnati, Ohio, June 28, 1883.

CAPTAIN: I have the honor to submit the following report of operations on the Big Sandy River, West Virginia and Kentucky, during the months of August, September, October, November, and a part of December, 1882, at that time under the direction of Maj. James W. Cuyler, United States Corps of Engineers.

The character of the work and general plan of operations were the same as had been projected and carried on in past seasons on the upper Big Sandy River.

Two working parties were organized (one for each fork) and furnished with push-boats, tents, provisions, blasting material, and all necessary tools to perform the required work, namely, the removal of all obstructions, rocks, snags, fallen trees, and stumps from the natural channel and sharp bends of the river, to improve the shoals by constructing chutes and raft-channels, so as to extend steamboat and push-boat navigation as far up the river as possible, and to aid the vast timber interest of this valley in drifting timber rafts safely to the mouth of the Big Sandy River.

The experience of past low-water seasons had shown the advantage of gaining the headwaters of both forks as early as possible and working down-stream.

From August 20 to September 1 the time was consumed at Louisa, Ky., in repairing and fitting up the boats for the season's work.

TUG FORK.

September 1 the Tug Fork flotilla, of two push-boats, skiff, joe-boat, and canoe, with a crew of twenty-five men, left Louisa, Ky., for the Roughs of Tug.

Progress was slow, owing to high water and a rising river, and after pushing against storm and flood, steep shoals, and strong currents incident to this mountain stream, the boats reached the foot of the Roughs September 18, 96 miles above Louisa, Ky.

I did not deem it advisable to send the large boats into the Roughs, on account

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of the wear and tear they would receive in climbing over the unimproved shoals; so a camp was pitched on Ben Island, at the foot of the Roughs.

The work of blasting solid rock, removing boulders, constructing push-boat chutes and raft-channels was commenced where it left off at the close of the season's work of 1881, about 2 miles above the foot of the Roughs. Shoals Nos. 7, 6, 5, 4, 3, 2, and 1 were improved by constructing push-boat chutes from 15 to 20 feet wide, and all large boulders blasted and removed; also, large quantities of solid rock from the sharp bends in the river, that imperiled the drifting of timber rafts and loose saw-logs.

The work in the Roughs closed October 3.

From the foot of the Roughs to the Hatfield Dam (the point reached working upstream from Warfield, Ky., in 1890), about 20 miles, had never been improved under the present system, and a large amount of blasting was required to improve this stretch of river for push-boat navigation and timber drifting.

The following shoals were improved and obstructions removed as follows:

Ben Creek Shoal, by constructing a push-boat chute from the north end of mill-dam to the foot of the shoal.

The "Alum Rock," on the Kentucky side, was entirely removed; Alum Shoal, by dredging a chute and building a raft-channel; Slick Rock Shoal, by blasting a push-boat chute in the solid bed rock, 549 feet long 9 feet wide and 1 foot deep; Bull and Hard Fortune shoals, by constructing chutes and removing large boulders from the natural raft-channel. Blasted and removed the "Grant Rocks" from the Kentucky side, and improved the Grant Shoal, by building a push-boat chute 1,437 feet long. Long, Blankenship, Knox, Beach, Mounts, and Hatfield shoals were improved by constructing chutes and raft-channels, and removing large rocks from the bends of the river.

At Hatfield Bar a new straight chute was cut through the gravel bar, and the natural low-water chute stopped by building a riprap wing-dam 2 feet high.

The work down-stream from this point consisted mainly in deepening, widening, and straightening the old push-boat chutes, repairing and rebuilding riprap wing-dams, and removing snags and fallen trees from the steamboat channel.

The party worked on down the Tug Fork to its confluence with the Louisa Fork, where the season's work closed, and the boats arrived at Louisa, Ky., December 6, and the crew was discharged.

LOUISA FORK.

The Louisa Fork party of fifteen men left Louisa, Ky., August 28, with two push-boats, and reached the forks of the Louisa Fork (98 miles above Louisa) upon September 6.

The water being too high to improve the shoals, the party worked up-stream for 2 miles, removing snags and blasting rock in the sharp bends of the river; returning down-stream, a large rock, on the right bank opposite the mouth of Russell Fork was blasted and removed, and all snags and fallen trees removed from the mouth of Russell Fork. Also removed one of the old bridge piers at this point that obstructed timber rafts, blasted rock, and cut off the point at the "Turnhole," thus destroying the swirl below; improved the Turnhole Shoal ford by removing rock, and worked on down-stream, snagging and blasting rock in the sharp bends, to Piketon, Ky. (86.5 miles above Louisa, Ky.), the head of steamboat navigation.

From Piketon down-stream, snags, stumps, fallen trees, and rock were removed at or near the following localities: Long Shoal, mouth Tollets Creek, Stone Coal Creek, Grimes Shoal, Lanesville Post-Office, 72 miles above Louisa; Jack Strattons and Prater shoals; Hawes Ford and Shoal; mouth Albert Creek to Moody George Shoal; mouth of John's Creek to Little Paint Creek, Conly Shoal; between Hell Gate Shoal and Paint Creek, 36 miles above Louisa; Greasy Shoal, mouth Greasy Creek, Big White House, Chestnut, Lost Creek, Bumble Bee and Greaves shoals, Peach Orchard, 17 miles above Louisa.

At George's Creek, 14 miles above Louisa, a large drift pile and seven large fallen trees were removed, so that the river might resume its natural channel. Snags were also removed from the mouth of Twin Brothers Creek, Contrary Shoal, Twin Brother Shoal, and Five-Mile Shoal. This completed the work on the Louisa Fork, and the boats and crew arrived at Louisa, Ky., November 4.

MAIN RIVER.

Having asked for and received authority to work a party on the Big Sandy River, from Louisa, Ky., to the mouth of the river, 26 miles, I sent the Louisa Fork party on down the main river removing snags, stumps, and rocks.

The "Jonah Hatton Rock," 12 miles below Louisa, has been a serious obstruction to steamboats and rafts, and this rock was blasted and all removed down to extreme low-water mark.

Snags and stumps were removed from the mouth of Bear Creek, Rush Creek, Virginia Whites Creek, and just above Savage Branch:

Stumps were removed from both banks of the river from England Hill to the mouth of Big Sandy River, to facilitate the landing of timber rafts.

This completed the season's work on the main river, and on November 30 the boats were towed back to Louisa, Ky., and the crew discharged.

The results of the season's work on the Big Sandy River and its tributaries may be summed up as follows: Free and unobstructed navigation for steamboats as far up the Tug and Louisa forks as their limited steam-power will carry a paying load of freight or passengers.

Well defined push-boat chutes up the Tug Fork, that will enable supplies to be boated up to the extreme headwaters, 118 miles above Louisa, Ky., and the safe drifting of timber rafts, loose saw-logs, and staves from the headwaters of both forks to the Ohio River.

The following table shows in detail the amount of work done during the season of 1882 on the Big Sandy River, West Virginia and Kentucky:

Location of work.	Snags removed.	Average length.	Average butt circumference.	Fallen trees removed.	Average length.	Average butt circumference.	Stumps removed.	Shoals improved.
	No.	Feet.	Feet.	No.	Feet.	Feet.	No.	No.
Tug Fork	81	27.7	6.8	2	43	8.0		49
Louisa Fork	817	35.7	6.1	20	51	8.6	182	19
Big Sandy	77	41.3	8.3				15	
	945	35.7	6.3	22	50.2	8.5	197	49

Location of work.	Chutes constructed.	Raft-channels constructed.	Solid rock blasted and removed.	Loose rock removed.	Days worked during season.	Distance worked over.	Distance traveled by boats.	Men employed.
	No.	No.	Cu. yds.	Cu. yds.	No.	Miles.	Miles.	No.
Tug Fork	36	41	5,499.2	2,428.9	86	98	196	28
Louisa Fork			191.5		63	101	202	19
Big Sandy			300.0		22	26	52	13
	36	41	5,990.7	2,428.9	171	225	450	60

Exports, Big Sandy River, from July 1, 1882, to July 1, 1883.

Articles.	Quantity.	Weight.	Value.
PRODUCE.			
Apples:		Pounds.	
Dried	382 bags	38,200	\$1,910
Green	510 barrels	63,750	765
Butter	404 boxes	12,205	3,462
Beeswax	85 do.	3,400	1,020
Beans	638 bags	82,946	3,317
Corn	1,105 do.	110,500	2,710
Eggs	2,975 cases	238,000	9,250
Feathers	1,148 bags	110,500	44,200
Furs	298 do.	14,900	2,465
Ginseng	277 do.	24,930	24,930
Honey	170 boxes	9,350	1,010
Hides	595 bales	12,750	1,700
Leather	425 do.	52,700	14,450
Oats	595 bags	35,700	475
Peaches, dried	1,870 do.	112,200	6,800
Potatoes	340 do.	34,000	850
Rye	425 do.	10,200	850
Roots	2,125 do.	106,250	25,500
Sorghum	6,800 barrels	3,400,000	137,000
Sheep-pelts	64 bales	3,200	1,600
Tobacco	22 hogsheds	22,000	3,080
Tallow	64 barrels	25,600	1,600
Wheat	12,750 bags	1,657,500	31,875
Wool	16,745 do.	144,500	51,775
		6,325,275	372,472

1570 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Exports, Big Sandy River, from July 1, 1882, to July 1, 1883—Continued.

Articles.	Quantity.	Weight.	Value.
LIVE STOCK.			
		<i>Pounds.</i>	
Cattle	number.. 3,570	2,856,000	\$83,000
Chickens	do... 40,800	170,000	8,500
Ducks	do... 408	1,632	81
Geese	do... 468	5,100	187
Horses	do... 255	331,500	20,000
Hogs	do... 3,400	680,000	40,000
Mules	do... 77	84,700	7,700
Sheep	do... 1,700	255,000	3,000
Turkeys	do... 1,275	12,750	1,000
		4,396,682	167,700
TIMBER.			
		<i>Cubic feet.</i>	
Ash logs	number.. 2,125	54,000	8,704
Oak logs	do... 25,500	680,000	95,200
Poplar logs	do... 62,250	3,570,000	400,000
Walnut logs	do... 10,200	255,000	127,500
Mixed logs	do... 4,250	136,000	16,300
		4,685,000	717,340
LUMBER.			
Lumber, feet, B. M.		5,950,000	119,000
Lumber, walnut, B. M.		85,000	3,400
Walnut knols			93,500
Hoop-poles	number.. 8,500		850
Staves	do... 6,800,000		170,000
Tan-bark	cords.. 850		11,900
			396,650
Total value of produce			\$372,172
Total value of stock			167,700
Total value of timber			717,340
Total value of lumber			396,650
Total export			1,653,860
Imports as per estimate			762,650
Total			2,416,510

A A 3.

IMPROVEMENT OF GUYANDOTTE RIVER, WEST VIRGINIA.

The operations of the past year have been conducted with a view of extending and completing the improvements heretofore made. This consisted in removing snags, rocks, and shoals, so as to open a clear channel for push-boat and raft navigation, 30 feet wide and 18 inches deep at the lowest stage of the water. Work during the past year was commenced at Justice Bar, 28½ miles above Logan Court-House, or 110 miles above the mouth of the river, and extended up-stream 12 miles.

The following localities were improved, namely: Blankinship, Skin and Leatherwood shoals, by removing solid rock and bowlders from the bed of the stream. The channel was improved at Hickory Dam and Cub Creek Island, by cutting leaning trees and removing stumps and snags and closing one channel by building brush and rock dams to concentrate the water in a single channel. Toler's Shoal was dredged and

Toler's Bar was cut down so as not to obstruct the passage of the timber rafts. At Zac Shoal, rocks and bowlders were removed and trees were cut along both banks of the river.

The work at several shoals below Logan Court-House that had been partly improved was completed.

The following is a summary of the work done:

Solid rock blasted and removed	cubic yards..	600
Loose rock and bowlders	do.....	100
Stumps destroyed	number..	100
Leaning trees cut	do.....	22
Brush and rock dams built	linear feet..	1, 030

To obtain the full benefit of the improvements made it will be necessary to remove the two private mill-dams known as Peck's and Rogers's, the former $74\frac{1}{2}$ miles and the latter 13 miles from the mouth of the river. These are not only serious obstructions, but a source of danger to the navigation of the river. It is recommended that Congress authorize the Secretary of War to take such steps as are required for their removal, and provide for the payment of all the necessary expenses, including their purchase, if that cannot be avoided. It is possible that a chute of suitable size placed in these dams would fully meet all the requirements at the present time. As they are supposed to be private property, it is not unlikely that this would be quite as expensive as their complete removal, while it would be much less satisfactory. They are very old, leak badly, and cannot be of much value.

An appropriation of \$5,000 would probably be sufficient to remove all the obstructions.

It is proposed during the present year to make additional improvements now needed between Logan Court-House and Rogers's Mill-dam, especially at Musk Rat and Little Ugly shoals, and remove the snags, trees, and bowlders which have been brought into the river by the recent freshets.

Since this improvement has been commenced the following appropriations have been made:

By act of Congress June 18, 1878	\$2, 000
By act of Congress March 3, 1879	1, 000
By act of Congress June 14, 1880	2, 000
By act of Congress March 3, 1881	3, 500
By act of Congress August 2, 1882	2, 000

Total..... 10, 500

Total amount expended to June 30, 1883, \$9,081.12.

Money statement.

July 1, 1882, amount available	\$246 36
Amount appropriated by act passed August 2, 1882	2, 000 00
	<hr/>
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	2, 846 36
	1, 427 48
	<hr/>
July 1, 1883, amount available	1, 418 88
	<hr/>
Amount that can be profitably expended in fiscal year ending June 30, 1885 ..	5, 000 00

1572 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Commercial statistics for fiscal year 1882 and 1883.

No.	Articles.	Quantity.	Price.	Value.
700	Poplar rafts.....cubic feet	1,750,000	12 cents per foot.....	\$210,000
850	Oak rafts.....linear feet	400,000	25 cents per foot.....	100,000
100	Walnut rafts.....cubic feet	150,000	50 cents per foot.....	75,000
	White-oak staves.....number	7,000,000	\$15 per M.....	105,000
	Tan-bark.....cords	2,000	\$15 per cord.....	30,000
	Wool.....pounds	15,000	40 cents per pound.....	6,000
	Feathers.....do	5,000	40 cents per pound.....	2,000
	Ginseng, dried.....do	20,000	\$1.50 per pound.....	30,000
	Lumber, sawed.....feet	200,000	\$1.50 per M.....	3,000
	Wheat.....bushels	4,000	\$1 per bushel.....	4,000
	Corn.....do	20,000	30 cents per bushel.....	6,000
	Rye.....do	2,000	50 cents per bushel.....	1,000
	Oats.....do	10,000	40 cents per bushel.....	4,000
	Potatoes.....do	2,000	\$1 per bushel.....	2,000
	Apples.....barrels	1,000	1.30 per barrel.....	1,300
	Tobacco.....pounds	40,000	10 cents per pound.....	4,000
	Butter, eggs, and other produce.....			15,000
	Exports.....			604,300
	Imports.....			375,000
	Total.....			979,300

A A 4.

IMPROVEMENT OF LITTLE KANAWHA RIVER, WEST VIRGINIA.

During the past year operations on this river have been confined to receiving the dimension stone and rubble under the contract of April 17, 1882, with Thomas B. Townsend for the lock to be constructed above Burning Springs. A portion of this stone has also been dressed.

The contractor finding that he would be unable to complete his contract at the date designated by its terms, applied to have the time extended from September 30, 1882, to September 1, 1883. This was granted upon recommendation to the Chief of Engineers.

From December 1 until the following May no stone was received or stone-cutting done on account of the cold weather and high water.

The following amounts were received during the year: 968.3 cubic yards dimension stone, and 534.7 cubic yards rubble stone.

The estimates for this lock and dam heretofore made places its cost at \$101,000. This is much too small in view of the advance in the price of both labor and materials. A careful revision based upon the latest information obtained has been made, and is given in detail, as follows:

ESTIMATE FOR LOCK.

1,890 cubic yards concrete, at \$6 per cubic yard.....	\$11,340 00
7,007 cubic yards foundation excavation, at 35 cents per cubic yard.....	2,452 45
1,963 cubic yards earth excavation, at 25 cents per cubic yard.....	491 25
1,720 cubic yards foundation masonry, at \$11 per cubic yard.....	18,920 00
4,507 cubic yards quarry face masonry, at \$9.50 per cubic yard.....	42,816 50
294 cubic yards cut stone, at \$14.25 per cubic yard.....	4,189 00
Four valves and fixtures, at \$150 each.....	600 00
Four gates and anchorages, at \$1,000 each.....	4,000 00

Engineering and contingencies.....	84,809 20
	8,480 92

93,290 12

ESTIMATE FOR TIMBER DAM.

	Per running foot.
218 cubic feet lumber and sheeting, at 25 cents per cubic foot	\$54 50
18 cubic yards riprap filling, at \$1 per cubic yard	18 00
Drift-bolts and spikes	8 00
Labor	18 00
Cost per running foot	98 50
Cost of 234 feet dam, at \$98.50 per running foot	23,049 00
Engineering and contingencies	2,304 90
	25,353 90

COFFER-DAM.

98,366 feet, B. M., for sheeting, piling, wales, clamps, &c., at 25 cents per ft.	\$2,459 14
8,112 linear feet crib-timber and piles, 15 cents per foot	1,217 80
2,497 pounds bolts, spikes, &c., 4 cents per pound	99 88
10,844 cubic yards earth excavation, at 25 cents per cubic yard	2,711 00
	6,487 82
Engineering and contingencies	648 78
	7,136 60

COST OF MASONRY ABUTMENT.

760 cubic yards coursed rubble, at \$8.50 per cubic yard	\$6,460 00
706 cubic yards earth excavation, at 25 cents per cubic yard	176 50
204 square yards paving bank, \$2.16 per square yard	440 64
133 cubic yards rock excavation, \$2 per cubic yard	266 00
	7,343 14
Engineering and contingencies	734 31
	8,077 45

TOTAL COST OF LOCK AND DAM.

Masonry lock	\$93,290 12
Timber dam	25,353 90
Coffer-dam for lock	7,136 60
Masonry abutment	8,077 45
Lock-keeper's house	1,200 00
Site for lock and dam	614 40
	135,672 47

By act of Congress passed August 2, 1882, \$31,000 was appropriated for this work, with the proviso—

That no part of this amount shall be expended until the Little Kanawha Improvement Company shall have filed with the Secretary of War, to be approved by him, its agreement not to charge in any manner any tolls on the Little Kanawha River.

Correspondence has been had with this company, but they have failed to comply with this condition, and there seems to be very little probability that they will do so. This money is, therefore, not available for this work, and is not likely to be without further action of Congress.

It is proposed during the present year to complete the contract for receiving the stone in the rough for this lock. The cutting of the stone will also be completed. If an additional appropriation is made, or the appropriation of last year is made available, it is then proposed to commence the construction of the lock.

For the maintenance of the channels by removing obstructions, and the repairs of the works of improvement already made in the upper portion of the river, an appropriation of \$2,000 is recommended.

1574 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Since the works of improvement have been commenced, the following amounts have been appropriated to date:

By act of Congress August 17, 1876.....	\$7, 30
By act of Congress June 18, 1878	15, 00
By act of Congress March 3, 1879	15, 00
By act of Congress June 14, 1880	15, 00
By act of Congress March 3, 1881	40, 00
By act of Congress August 2, 1882	31, 00
Total.....	129, 30

Of this amount \$43,300 was for the improvement of the river for open river navigation, by the removal of obstructions both artificial and natural, all of which has been expended. The remaining \$86,000 was for the construction of a lock and dam.

Total expended, outstanding liabilities included, \$67,032.30.

Money statement.

July 1, 1882, amount available.....	\$48, 663 58
Amount appropriated by act passed August 2, 1882.....	31, 000 00
	<hr/> 79, 663 58
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$15, 495 92
July 1, 1883 outstanding liabilities	1, 899 96
	<hr/> 17, 395 88
July, 1, 1883, amount available.....	<hr/> 62, 267 70
Amount (estimated) required for completion of existing project.....	49, 673 02
Amount that can be profitably expended in fiscal year ending June 30, 1885.	49, 673 02

Commercial statistics for fiscal year 1882 and 1883.

[Taken from the books of the Little Kanawha Navigation Company from February 1, 1882, to February 1, 1883.]

Articles.	Quantity.	Toll collected by Little Kanawha Navigation Company.
Staves.....number.....	1, 322, 000	\$697 68
Packets.....do.....		4, 746 85
Rafts.....do.....	1, 208	4, 759 36
Oil.....barrels.....	4, 200	714 00
Lumber.....feet, B. M.....	6, 280, 000	2, 234 61
Coal.....bushels.....	14, 900	121 50
Cross-ties.....number.....	623, 000	9, 714 33
Barges empty.....do.....		2, 979 40
Tow-boats.....do.....		519 00
Miscellaneous.....do.....		519 57
Total		<hr/> 28, 806 80

A A 5.

IMPROVEMENT OF TRADEWATER RIVER, KENTUCKY.

The act of Congress of August 2, 1882, appropriated \$3,500 for continuing the improvement of this river. As a considerable portion of the working season had been consumed before this money was available and additional delay would take place before a party properly equipped could get into the field, it was considered in the interests of

economy to postpone further work until the present year. This plan received the approval of the Chief of Engineers under date of August 14, 1882. There was, therefore, no work done during the fiscal year just ended.

The Tradewater River is a narrow, tortuous stream, emptying into the Ohio River just below Caseyville, Ky., which drains a basin or valley about 60 miles long and 20 miles wide in the western part of the State of Kentucky.

The improvement proposed was the removal of snags, overhanging trees, bowlders and rock bars. This has been done for a distance of 7 miles from its mouth, and a channel 40 feet wide with a minimum depth of 2.6 feet at low water has been formed.

During the present year it is proposed to increase the size of this channel to 70 feet in width, and 3 feet deep at low water. The work of clearing the river will also be continued up-stream as far as the amount appropriated will permit.

The coal region of the Tradewater embraces the whole valley, and a considerable quantity of coal of an excellent quality is being mined. The other productions of this valley are tobacco, wheat, corn, Irish potatoes, cattle, and hogs, in quite large amounts. In the absence of any information it is impossible to say to what degree the amount of production has been increased by the improvements made.

The following amounts have been appropriated for this work:

By act of Congress of March 3, 1881.....	\$3,000
By act of Congress of August 2, 1882.....	3,500
Total	<u>6,500</u>
Total amount expended to June 30, 1883	<u>2,997 08</u>

Money statement.

July 1, 1882, amount available	\$2 92
Amount appropriated by act passed August 2, 1882.....	3,500 00
July 1, 1883, amount available	<u>3,502 92</u>
Amount (estimated) required for completion of existing project	<u>10,000 00</u>
Amount that can be profitably expended in fiscal year ending June 30, 1885	5,000 00

APPENDIX B B.

IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS, AND OF WHITE RIVER, INDIANA.

*REPORT OF MAJOR JARED A. SMITH, CORPS OF ENGINEERS, OFFICER
IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH
OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Wabash River, Indiana and Illinois. 2. White River, Indiana.
-

UNITED STATES ENGINEER OFFICE,
Indianapolis, Ind., July 28, 1883.

GENERAL: I forward herewith annual reports for the river and harbor improvements in my charge for the year ending June 30, 1883.

Very respectfully, your obedient servant,

JARED A. SMITH,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

B B 1.

IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS.

BELOW VINCENNES.

At the beginning of the fiscal year the available funds were too small in amount to permit any work save the care of plant.

The act of August 2, 1882, appropriated \$40,000 for continuing the improvement.

A project was submitted to continue the removal of snags and the improvement at Little Chain; to make necessary repairs to the dam at New Harmony, and to commence the reconstruction of the lock and dam at Grand Rapids.

It was August 26 before operations could be resumed, and if any further delays were caused nothing could be accomplished until another year.

For this reason, added to the fact that the improvements are such that they cannot be satisfactorily done otherwise, all purchases have been made in open market and the work has been done by hired labor. Capt. B. Hutcheson, inspector, has had general supervision of the working parties, and has discharged the duty with energy and ability.

GRAND RAPIDS LOCK AND DAM.

The excavations and foundations could not be judiciously undertaken in the autumn, and the work was therefore deferred until spring in the anticipation that an additional appropriation would permit more extensive operations, so that the lock walls might be brought above ordinary stages of water in a single season.

Congress having failed to make any appropriations for such improvements in the next fiscal year, it seemed better to defer commencing this important improvement and to finish, if possible, the one at Little Chain, rather than to add to the list of works which must of necessity be left incomplete for an indefinite time.

This has always been the most important and most needed improvement on the river, and estimates for the construction have been submitted with nearly every annual report; it has been postponed from year to year partly because no specific appropriation has been made therefor, and for other reasons which I cannot better express than by quoting the following from my annual report for 1880:

With small appropriations the most important improvements cannot be judiciously undertaken, as their cost is largely increased by being several years in progress, and there is no certainty of their completion. As a result, numerous small improvements are made, which, while they benefit navigation, are not vital, and the essential works are thus constantly left upon the list to be done in the indefinite future, and the annual estimates for their completion are but little, if any, reduced by the work already accomplished.

The lock and dam are estimated to cost \$130,000, and it is earnestly recommended that one-half the amount be appropriated for that especial purpose during the fiscal year ending June 30, 1885.

LITTLE CHAIN.

A working party, with such barges and appliances as were available, left Mount Carmel, Illinois, in the afternoon of August 26, were towed to Little Chain and went into camp.

The location, unhealthy at all times, was especially so during the remainder of the season, and at one time, of a force of twenty-eight men, fourteen were sick of malarial fevers. The difficulty attending any progress under such circumstances needs no comment. The inclemency of the season compelled a suspension of the work November 11, giving but little more than two months to the improvement.

The dam of piles, brush, and stone built across the cut-off in 1879 was found to require repairs, one of the banks having washed away. To prevent further injury, the repairs were made as soon as the party arrived at Little Chain. In this work there were used—

Fascines, 10 feet long and 1 foot diameter.....	1,822
Loose brush	337
Stone.....	304½
	cords..
	cubic yards..

The work of cutting a channel through the reef was resumed in the latter part of September.

Seven hundred and sixty-four and a half cubic yards of stone were removed, 460 of which were placed in the dike, and 304½ were transported somewhat more than half a mile to use in repairing dam in cut-off. A considerable amount of stone was blasted, but not removed from the channel; 3,633 linear feet of 3-inch holes were drilled and exploded, and 1,101 pounds of dynamite were used.

Nine thousand nine hundred and seventy-six feet of boards were used in temporary camp and dam across channel.

A derrick was fitted up for raising the rock, but most of the work had to be done by men standing in the water, as to construct and maintain a suitable coffer-dam would cost more than the amount allotted.

The entire amount expended in the channel and cut-off at Little Chain is \$5,300.97.

A party with the new dredge was returned to Little Chain in the latter part of June, but high water has thus far prevented a resumption of work.

DREDGE.

The amount available for the improvements has been so small that the purchase of any expensive appliances has been avoided as far as possible, but it became evident that there was no economy in this course for such works as Little Chain, on the Wabash, and Kelly's Ripple, on the White River.

The necessary machinery for a boom dredge has therefore been purchased; a good hull has been made by repairing an old barge, and the entire machine, although not yet housed in, is in condition to work as soon as the present high water subsides.

The dredge is to be used on both the Wabash and White rivers, and the expense, about \$10,000, is divided between the two improvements.

GRAND CHAIN.

Some injuries to the timber dike, by passing drift, made a few repairs necessary in November. The timbers torn away were replaced with 1,342 linear feet of oak logs, secured by 570 pounds of three-quarter-inch round drift bolts.

The expense was \$371.74.

TURKEY ISLAND DAM.

A portion of the brush and stone filling of this work having been displaced by high water and passing drift, it was deemed advisable to restore it. The repairs were made in October. One hundred and seven cords of brush were cut and hauled 1 mile to the dam, and 192 cubic yards of stone were quarried, transported about 8 miles up-stream, carted a short distance, and placed on the brush in the dam.

The repairs at this place cost \$671.70.

NEW HARMONY DAM.

This dam was first built in 1876, and upon it depends the entire navigable channel for 12 miles below New Harmony, besides considerable benefit for several miles above that town.

The situation is such that until the cut-off can be entirely filled with drift the preservation of the dam and its surroundings will require constant attention.

The island against which the dam abuts is of a sandy soil, so soft that when exposed a slight current washes it rapidly away. Several depressions occur in the island near the dam, through which the water flows at high stages, each year showing some new break as its old ones are prevented.

During the spring of 1882 the heavy trees drifting at extreme high water tore away some of the top of the dam, and the current cut various holes and furrows upon the adjacent land.

Complete repairs were made in September, October, and November. The following materials were used in the dam :

Logs.....	linear feet..	7,051
Oak plank.....	do.....	6,000
Stone.....	cubic yards..	676
Drift bolts.....	pounds..	1,404
Spikes.....	do.....	300
Earth and shale.....	cubic yards..	900

Above the dam a crib, 30 by 25 by 15 feet, was placed, to aid in catching and retaining the drift. This crib contained—

Logs.....	linear feet..	965
Drift bolts.....	pounds..	576
Stone.....	cubic yards..	231

In protecting the island there were used—

Brush.....	cords..	268
Stone.....	cubic yards..	312

The expense of the entire repair was \$3,496.35.

REMOVAL OF SNAGS.

The snag-boat Kwasind, with a small crew, was used to tow the barges from Mount Carmel to Little Chain, late in August, and returned with the same November 11 and 12. In the interval the boat was employed removing snags between Little Chain and the mouth of the river, a distance of 26 miles; one hundred and thirty-four snags were removed, divided six hundred and thirty-one times, and deposited.

The estimated weight of the heaviest snag was 53 tons, and the average weight 5.2 tons.

The greatest length of a snag was 129 feet, and the average length of all was over 60 feet.

Seventy-five overhanging trees were cut away and removed to prevent their falling into the river and becoming snags. These were divided by ax or saw-cuts in three hundred and seventy-eight places.

In doing the work the boat ran 592 miles.

The snag-boat has been kept in good order during the year. As the lack of funds prevents its constant employment the ensuing season, it has been used to tow the barges to Little Chain, and will do any towing that may be required during work at that place.

The entire expense of the snag-boat for operating and maintenance has been about \$4,500.

EFFECT OF THE IMPROVEMENTS.

Between Mount Carmel and the mouth of the river, a distance of 90 miles, the worst snags have been removed from the channel, so that but little inconvenience or danger to navigating that part of the river now comes from that source.

The improvement at Grand Chain, although a benefit, has not accomplished all that was hoped for it, and it will require further attention.

The various shore protections, wing-dams, and dams across cut-offs have all accomplished their purpose, to the great relief of various steamers engaged in river traffic.

CONDITION OF THE RIVER.

The constantly changing channel in the lower portion of the river has caused the formation of two extensive bars, which at extreme low water are complete obstructions to any save the very smallest steamers.

These bars may very easily be remedied by wing-dams, which will narrow the channel and retain it in one place. The expense will not be great, but it cannot be accurately estimated, as the extent to which work must be carried can only be known by observing the effect as it progresses.

It is hoped that a channel of sufficient width may be completed at Little Chain during the ensuing season to permit boats to pass, but it will require something further to complete the improvement.

The original estimate was \$39,000; and at the end of the present season it is probable that not more than \$25,000 will have been expended, including all machinery.

Until places where banks are cutting away can be protected, new snags will be arriving and other conditions will form, though these will be reduced in quantity from year to year as improvements progress.

The neck of the peninsula opposite Grayville, Ill., is now in very serious danger, the long-continued, high stages of water in the past two years having broken the levee and made a large crevasse across the land. There is a pressing necessity for extensive repairs at this place to prevent the formation of a new channel, which would not only cut the town and its extensive business off from the river navigation, but would convert the old channel into an unwholesome slough.

An expenditure of \$10,000 at this place to repair damages and prevent further injury would be judicious.

PROJECT FOR ENSUING YEAR.

It is proposed to continue the improvement at Little Chain so long as the funds will permit, reserving a sufficient amount to care for boats and other plant, until Congress shall have decided upon the question of an appropriation for the fiscal year ending June 30, 1885.

Should no appropriation be made, all the property belonging to the improvement must be sold.

ESTIMATES.

It is impossible to make a definite estimate for the complete and permanent improvement of a river like the Wabash. Each particular work may be fairly estimated upon, but new conditions which cannot be foreseen will arise in places.

The lock and dam at Mount Carmel has been estimated to cost \$130,000, one-half of which could be profitably expended in a single year, in addition to other improvements for which an appropriation of \$50,000 is recommended.

Money statement.

July 1, 1882, amount available.....	\$444 11
Amount appropriated by act passed August 2, 18-2.....	40,000 00
	<hr/> 40,444 11
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$21,691 04
July 1, 1883, outstanding liabilities.....	659 14
	<hr/> 22,350 18
July 1, 1883, amount available.....	18,093 93
Amount that can be profitably expended in fiscal year ending June 30, 1885.	<hr/> <hr/> 115,000 00

IMPROVEMENTS FROM VINCENNES TO LA FAYETTE.

The modifications of steamer and construction of a new pile-driver, mentioned in last annual report, were completed September 21. Operations were at once commenced by towing the snag-scow and pile-driver to their respective scenes of operations.

Work was continued until November 20, when the cold weather compelled the fleet to start for Mount Carmel, the nearest accessible point for safety during the winter.

Extreme low water and ice detained the fleet between Vincennes and Mount Carmel until December 24, when it succeeded in arriving at the winter harbor in the mouth of Patoka Creek, opposite Mount Carmel, Ill.

REMOVAL OF SNAGS.

The work was continued during the autumn months as before indicated, and was resumed in June, 1883.

Operations have been limited to the section of river between Vincennes and Terre Haute, owing to the difficulty of proceeding above the latter place from causes explained under the head of "bridges."

Two hundred and sixty-two snags have been removed from the channel, cut in pieces by six hundred and three divisions and deposited in places least likely to permit a return.

The average weight of these snags, estimated by calculation, was nearly $6\frac{1}{2}$ tons, the largest being 53.3 tons, and the longest was 129 feet.

Besides the snags seventy-two overhanging trees were likewise removed and cut in pieces by one hundred and twenty-three divisions.

The soft pine bottom of the tow-boat was repeatedly broken and punctured by snags, and it became necessary to replace it with a stronger bottom before resuming the work another season. Good oak plank was therefore procured and the boat was sent to the Government dry dock of the Louisville and Portland Canal. April 14, continued high water prevented the use of the dock until May 7.

The soft pine was replaced with a good oak bottom, a few other repairs were made, and on May 27 the boat was at Vincennes ready to resume its work.

The entire distance run in pulling snags, towing barges, and going to and from Louisville has been 2,707 miles.

The steamer is now in good condition, and will require but slight repairs for several years.

The expense of remodeling the boat with new machinery and a new bottom, making a few necessary repairs to the snag-scow, towing barges for other works, and removing the snags and trees indicated, has been \$12,700.75.

PILE-DRIVER.

The old machinery from the steamer has been adapted for use on the new pile-driver. An old barge was fitted up for a hull, and with quarters for the working party (the work being distant from any towns). The machine forms a valuable and necessary addition to the working plant.

Its entire expense was \$1,315.22.

DAM AT EIGHT-MILE ISLAND.

This island, so called from its being 8 miles below the highway bridge at Terre Haute, divides the river into two channels. A dam across the smaller channel, of sufficient height to cause all the water at low

stages to flow undivided, was so obvious an improvement that its immediate construction was decided upon.

A dam of brush and stone was designed, that being the most permanent and satisfactory for an inexpensive work, but the extreme low water prevented the use of the pile-driver save as quarters for the men, and a dam of cribs, brush, and stone was constructed instead.

The entire length of dam is 270 feet, and shore protections at each end extend 40 feet above and 90 feet below; a total length of 530 feet, and 12 feet wide.

As the bottom was soft it was covered with layers of brush, on which rest cribs filled with stone.

The height is but about 4 feet, the crest being 2 feet above extreme low water. The materials were difficult to procure, especially the stone, which was quarried several miles below, towed to a point above, wheeled ashore on a trestle-bridge, carted about one-fourth of a mile to the adjacent bank, and then wheeled to its location in the dam.

Transportation of other materials was almost equally tedious.

The dam was completed October 31, and comprised the following materials:

Cords of brush made into fascines	260
Oak logs	linear feet.. 4, 140
Drift bolts	800
Stone	cubic yards.. 915

The expense of the work, exclusive of towing done by the steamer, was \$2,163.52, about \$4.08 per linear foot.

SURVEY.

The survey of the river was resumed in the latter part of August and carried on until the end of October, after which it was impracticable to continue.

The field work has been carefully extended a distance of about 47 miles, making a total of 64½ miles on this part of the river.

The declivity of the river surface has been carefully taken and referred to permanent bench-marks; at extreme low water the average all is a trifle more than 6 inches per mile.

Soundings were taken across the river at intervals of 200 feet. The soundings, about twenty thousand in all, were located by transit intersections.

In the office all the work has been reduced and plated by rectangular co-ordinates on a scale of 200 feet to 1 inch. The topographical features to complete the maps have been added on three-fourths of the sheets.

The importance of the maps as an aid in studying the river and deciding what improvements should be recommended and how they should be made, is very great, and the survey should be continued until it connects with that already completed on the lower part of the river. The expense of the *field work* during the season was \$1,600.46, about \$33.33 per mile.

WAREHOUSE, ETC.

It has been necessary to repair the warehouses on the Government lands at Grand Rapids to provide a safe storage for the various implements; and to prevent theft and injuries from ice, fire, and water, watchmen have been required.

The employes retained during the winter have as far as possible been occupied in making the needed repairs to tools, machinery, boats, and buildings.

CONDITION OF THE RIVER.

The work already done has so far improved the channel between Vincennes and Terre Haute that two steamers have recently been making regular trips. One steamer was wrecked upon a snag about a year ago, but at present a clear channel exists between these two towns, so that steamers may and do ply regularly in the day time. Various small bars have disappeared as a consequence of removing the snags which caused them.

No examination has been made of the river from Terre Haute to Lafayette as it is impracticable to attempt the improvement of that part of the river so long as Congress and the State of Indiana permit the numerous bridges to remain entirely without draws, or with draws so badly arranged as to be of no use to passing boats.

BRIDGES.

The bridge for the public highway at Terre Haute has a narrow draw located entirely away from the low-water channel, so that at low stages of the river an extensive sand-bar entirely above water covers the site.

Above this point several bridges have been built in entire disregard of the rights of the United States in its navigable waters.

Complaints have been received, but the officer in charge of the improvements is helpless to remove or reduce the obstructions.

In March last one of three complaints was forwarded to the honorable Secretary of the Treasury, and by subsequent references reached this office for report.

As the letter, report, and action thereon by the Department of Justice set forth the situation fully, they are here given:

LETTER OF MR. S. R. SHEWMAKER TO THE HON. THE SECRETARY OF THE TREASURY.

THE MURDOCK HOTEL,
Logansport, Ind., March 21, 1883.

DEAR SIR: I would respectfully submit the following statement of facts to your notice, and would be pleased to have your opinion upon the matter.

On Wabash River, between Terre Haute and Lafayette, there has been built several bridges which have no draws and which are not only dangerous but a serious obstruction to navigation. Steamers can only pass under them at very low stages of water, and even then have to lower their chimneys, and are laid up fully one half of the time unable to run on account of these artificial obstructions, and thereby causing a large amount of produce to be transported a long distance in wagons to a market, at a great loss to the producer on account of boats not being able to reach them.

As the steamers have to conform to all the rules and regulations of the steamboat inspection service (and have to be idle fully one-half the time on account of these obstructions), why should not the Government protect them and cause the removal of these obstructions, as they are built in direct violation of the law of constructing bridges across navigable streams?

Yours respectfully,

S. R. SHEWMAKER,
Murdock's Hotel.

The honorable the SECRETARY OF THE TREASURY.

REPORT OF MAJOR JARED A. SMITH, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Indianapolis, Ind., May 4, 1883.

GENERAL: I have to submit the following report in accordance with request in your indorsement dated April 9, 1883, upon a letter from the Treasury Department to the Hon. Robert T. Lincoln, Secretary of War, dated March 30, 1883, inclosing a copy of a communication from S. R. Shewmaker, of Logansport, Ind., complaining that bridges without draws have been built on the Wabash River between Terre Haute and Lafayette, Ind.

To procure the necessary information I directed Mr. O. L. Petitdidier, assistant engineer, to make a personal examination. This was done, and sketches in elevation

have been made showing the essential features of all the bridges between the places indicated, and also of three bridges at Lafayette.

A tracing of these sketches to form a part of this report is forwarded by this mail in a separate roll. The bridges are shown on the tracing in the same order that they occur on the river.

There are eight bridges on the river between Terre Haute and Lafayette, exclusive of three at each of these places. Of these eight bridges four are without draws. Another bridge without a draw is now in process of construction by the Chicago and Great Southern Railroad Company at Attica, Ind. Still another bridge without a draw formerly crossed the river at the town of Baltimore, but this bridge is now in ruins, leaving only the old piers as obstructions in the river.

These bridges are built in violation of the laws of the State of Indiana, which require draws in all bridges across rivers "navigable by steamboats" in this State. The laws are, however, loosely drawn, and the means of enforcing them are so obscure and indefinite as to make them of little or no value. This difficulty is increased, owing to the fact that the combined obstructions on this part of the river are such that but few boats engage in its navigation, those being of the poorest class and owned by persons of small means, while the bridges are built by railroad companies, or other moneyed interests, which pay but little attention to the protests of parties weaker than themselves.

I have no statistics of the navigation of this part of the river, but I understand it to be very small in amount.

In years past it was a common occurrence for steamers of considerable size to ascend the river as far as Lafayette, and but for the decay of the lock near Mount Carmel and the subsequent construction of numerous bridges and formation of other obstructions, this navigation would no doubt still continue.

Of the bridges having draws, the largest has a span of but 60 feet 2 inches, which is less than should be required to insure the safe passage of boats, though the laws of Indiana require but 5 feet greater span than the width of the largest boat navigating the portion of the river over which the bridge is built.

Congress has made an appropriation for improving the river as far up as Lafayette, but it will be impracticable to make any improvements above Terre Haute so long as such bridges may be constructed and maintained without authority from or interference by the United States.

Very respectfully, your obedient servant,

JARED A. SMITH,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

OPINION OF THE HON. THE ATTORNEY-GENERAL.

DEPARTMENT OF JUSTICE,
Washington, May 22, 1883.

SIR: I have the honor to acknowledge the receipt of your letter of the 12th instant, with the accompanying papers and documents, from which it appears that several bridges have been erected on the Wabash River between Terre Haute and Lafayette, in the State of Indiana, which bridges obstruct the navigation of the river, and render impracticable the improvements above Terre Haute, for which Congress has appropriated some \$30,000.

You apply to this Department and request that the necessary steps be taken to protect the interests of the Government in the premises.

I have examined the subject, and have been brought to the conclusion that the Executive branch of the Government can do nothing effectual to remedy the evil without the action of Congress.

The power to interpose when navigable waters are obstructed by bridges or otherwise is derived from the power to regulate commerce among the States.

Gilman vs. Philadelphia, 3d Wallace, 724.

In this case Mr. Justice Swayne said:

"Congress may interpose whenever it shall be deemed necessary, by general or special laws. It may regulate all bridges over navigable waters, remove offending bridges, and punish those who shall thereafter erect them."

This power is exclusive in Congress.

In the *Wheeling Bridge* case, 13th Howard, 564, Mr. Justice McLean, delivering the opinion of the court, said:

"An indictment at common law could not be sustained in the federal courts against the bridge as a nuisance, as no such procedure has been authorized by Congress." But he adds, "a proceeding on the ground of a private and irreparable injury may be sustained against it, by an individual or by a corporation."

A private party or a corporation suffering special damages, which are continuous or irreparable, may proceed by bill in equity to abate a public nuisance.

Mississippi & Missouri Railroad Company vs. Ward, 2d Black's Reps., 485.

So far then as private parties are injured by the bridges on the Wabash, they have the remedy in their own hands. But the Executive authorities of the United States cannot move in the matter, having received no warrant from Congress. In none of the reported cases where decisions have been made by the Supreme Court, which have reference to obstructions to navigation upon navigable waters, does the Government appear as a party.

I do not see that it alters the case, that Congress has appropriated money for the improvement of the navigation of the Wabash. The bridges have been built. There they are—with draws and without draws. Congress has not interposed. It has been silent while these expensive structures have been thrown across the river. Having exclusive power over the subject, it has hitherto declined to act. But to enable this Department to proceed against the bridges there must be express authority from Congress.

I have, therefore, the honor to return without action the original papers forwarded with your letter.

Very respectfully, your obedient servant,

BENJAMIN HARRIS BREWSTER,
Attorney-General.

HON. ROBERT T. LINCOLN,
Secretary of War.

As the matter now stands, any efforts or expenditure to improve such rivers may be completely overcome by any individual or corporation who chooses to construct or maintain an obstruction. It is therefore urgent that Congress should limit by statute the conditions and restrictions under which the construction and maintenance of bridges should be permitted across the Wabash and other such rivers legally and practically navigable.

PROJECT FOR ENSUING SEASON.

It is proposed to expend the available balance of the last appropriation in continuing the removal of snags during the summer and autumn, in continuing the survey of the river, and platting the maps; and in caring for the public property until Congress, at its next session, may determine whether it will be used in further improvements or sold from lack of employment.

FUTURE REQUIREMENTS.

Until the foregoing questions shall have been finally settled it will be nearly useless to attempt any improvements above Terre Haute. Between Vincennes and Terre Haute the removal of snags should be continued.

A dam is required in the cut-off at Horseshoe Bend, and there are numerous places where the banks should be protected, and where the channel should be otherwise confined to secure greater depth and permanence.

For continuing the improvement, as indicated, \$50,000 can be judiciously expended in the fiscal year ending June 30, 1885.

Money statement.

July 1, 1882, amount available.....	\$4, 023 30
Amount appropriated by act passed August 2, 1882.....	30, 000 00
	<hr/> 34, 023 30
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$19, 058 07
July 1, 1883, outstanding liabilities.....	1, 144 77
	<hr/> 20, 202 84
July 1, 1883, amount available.....	13, 820 46
Amount that can be profitably expended in fiscal year ending June 30, 1885.	<hr/> 50, 000 00

COMMERCIAL STATISTICS.

The commercial statistics for Wabash and White rivers are necessarily incomplete, owing to the failure of numerous parties to respond to inquiries.

At high stages of water, boats from the Ohio River take out large quantities of grain, live stock, and other freight, a statement of which it has been impracticable to obtain.

The following statement is of boats plying regularly upon the Wabash and White rivers:

Name of boat.	Tonnage.	Name of owner.	Where plying.
Rosa Belle (steamer and barge).	140	Cary & Blair.....	Grayville, Mount Carmel, and White River.
Belgrade (steamer and barge) ..	150	Tindolph & Agnew	Vincennes and Terre Haute.
Cornelia (steamer and barge) ..	90	Sid. H. Humphrey..	Mount Vernon and Little Wabash.
John R. Hugo	35.7	Charles Chadwick..	Wabash Switch and New Harmony.
Helen Hyatt (steamer and barge).	90	Elisha Hyatt	West fork of White River.
Lee Howell (steamer and barge).	85	C. W. Bowers	New Harmony, Grayville, and Mount Vernon.
Belle of Fountain	Not given..	Not given	Terre Haute and Hutsonville.
Staver	40	Thomas Deputy	Mount Carmel and White River.
Herman	Not given..	James Schee	Terre Haute to Pottsville.

The following shipments by steamers plying regularly are reported, but the amount in nearly all the items is far short of what a complete return would show; this is especially true in the items of grain, lumber, flour, and coal.

Wheat	bushels..	316,315
Corn	do.....	294,216
Flour	barrels..	5,536
Lumber	feet.....	505,333
Bolts	cords.....	1,466
Staves	thousands..	245,518
Merchandise	tons.....	1,473.5
Stone	cubic feet..	80,000
Lumber	tons.....	250
Stone	do.....	275
Bran	do.....	43
Coal	do.....	70
Skiffs	number.....	100
Passengers	do.....	2,243
Logs	number boated and rafted..	33,700

The saving of freight in the partial list given is estimated at \$52,475.97, but the benefits to a large section of these most productive lands in the country are not limited to the amounts carried on the river; for wherever the productions can be carried by water all railroad rates are reduced from 10 to 40 per cent. with an entire prevention of local discriminations.

The counties along the navigable part of these rivers produce at least 25,000,000 bushels of grain annually, and the reduction of freights by rail and water on the amount transported cannot be less than one-half the entire amount expended in making the navigation possible.

The reduction of freights increases the area of profitable production, adds to the amount exported, and enhances the price of lands.

B B 2.

IMPROVEMENT OF WHITE RIVER, INDIANA.

The work of the year has been confined to the removal of snags, the improvement of the channel at Kelly's Ripple, the partial construction of a dredge to assist in removing stone at Kelly's Ripple and other places, and the construction or repair of other necessary implements.

KELLY'S RIPPLE.

This improvement consists in cutting a channel about 2,100 feet long and at least 100 feet wide through the soft rock which forms the reef. It is expected to obtain a channel having a depth of at least 2 feet at the very lowest stages of water. This will be sufficient to accommodate a very large traffic, especially when it is remembered that the average depth during the season of navigation will be much greater than at low water.

To protect the new channel, as well as to afford a place to deposit the stone which is removed, a dike has been commenced, the base next the channel being held in position by cribs made of round timber.

Twenty-one cribs 20 feet square and 4 feet deep have been made and secured in position. This required—

6,628 linear feet of timber.

804 anchor bolts secured in the rock.

2,260 drift bolts made and driven.

2,483 cubic yards of rock were removed from the channel and placed in the dike.

The blasting required 10,755 linear feet of 3-inch holes, and 2,709 pounds of dynamite.

One hundred and fifteen linear feet of coffer dam and 320 linear feet of a dam of planks were constructed, as auxiliary works, requiring 12,906 feet of plank.

All the drilling and removal of stone has been done by men standing in the water, so that a high rate of wages became necessary.

The work was continued until November 18, when the inclement weather and high water made further progress impracticable.

A few appliances were made to facilitate progress, but it became apparent that several years would be required to complete the channel unless a dredge could be procured to remove the stone. The work will not be resumed until the new dredge is available for the purpose.

CONSTRUCTION OF DREDGE.

Authority was obtained to purchase machinery and to fit up a dredge, using an old barge as a hull. The dredge is to be employed on both the Wabash and White rivers, and the expense divided between the two improvements. A fuller description of the dredge and its purpose is given in the report of Wabash River improvement.

REMOVAL OF SNAGS.

The snag-boat resumed the removal of snags August 21, and continued until November 18, when it was laid up for the winter.

Attention was confined mainly to the portion of the river below Hazleton, 17 miles from the mouth.

Two hundred and seventy-three snags were removed from the channel, cut in pieces by fourteen hundred and thirty-nine divisions with saws and axes, and deposited where they are not likely to again obstruct the channel. The snags removed, if placed end to end, would reach more than 3 miles. The average computed weight was 5.4 tons, and the heaviest was over 38 tons.

In addition to the snags, one hundred and seventy-seven overhanging

trees were removed, cut in pieces by five hundred and eighty divisions, and deposited out of the way.

In doing the work the snag-boat ran 262 miles.

PROJECT FOR ENSUING SEASON.

As soon as the dredge can complete certain work on the Wabash River it is proposed to expend the funds now available in continuing the improvement at Kelly's Ripple.

CONDITION OF THE RIVER.

Most of the snags have been removed from the river below Hazleton, and, with the exception of Kelly's Ripple, there are but two places requiring attention; these are bars which can be removed by small wing-dams.

It is difficult to obtain suitable stone for these works, so that this item is a large element of expense.

Above Hazleton many of the worst snags have been removed, but much remains to be done. The wing-dams at Thorn's Eddy have not only protected the bank which was being rapidly cut away, but they have greatly improved the channel.

The worst obstructions on the river at present are the two railroad bridges, one built about two years ago across the river a short distance below the forks; the second being near Hazleton, to which attention has been called in former reports. The last-named bridge is a complete obstruction to all steamboats at medium stages of water. At very high water boats can pass through a kind of draw located over the shore, several feet higher than low-water level, and at extreme low water very small craft can pass under the bridge. Some modifications to the structure are proposed by the railroad company, but it is not known when they will be commenced or whether they will be undertaken at all.

The river has always been navigable in fact, and as it is beyond the power of the officer in charge of the improvements to remove or modify these bridges, although the results of money heretofore expended or to be expended above them will be rendered nearly nugatory as long as the obstructions are maintained, the especial attention of Congress should be urged to the subject.

FUTURE REQUIREMENTS.

It is estimated that \$25,000 will complete all the work which is contemplated below Hazleton; above that point much remains to be done in removing snags and sand-bars, but it is recommended that no further improvements be undertaken above Hazleton until such time as the obstruction caused by the bridge at that point shall be removed.

There has been no extensive navigation on the river during the past two years, mainly owing to existing obstructions and partial failure of crops. It is believed, however, that the improvements already made have affected a saving to the producers in the reduced rates, by railroad as well as water, sufficiently large to make the expenditure a good investment.

Commercial statistics for this river are embodied with those for Wabash River.

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Money statement.

July 1, 1882, amount available	\$8,298 67
Amount appropriated by act passed August 2, 1882	20,000 00
	<hr/> 28,298 67
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$20,583 29
July 1, 1883, outstanding liabilities	1,115 19
	<hr/> 21,768 48
July 1, 1883, amount available	<hr/> 6,530 19
Amount (estimated) required for completion of existing project	45,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	25,000 00

APPENDIX C C.

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

- | | |
|---|---|
| 1. Bridging Great Kanawha River, West Virginia. | 4. Bridges at Camden and near Pine Bluff, Arkansas. |
| 2. Pile and ponton bridge across the Mississippi River at Dubuque, Iowa. | 5. Bridging Lake Champlain at Rouse's Point, New York, and Alburg, Vermont. |
| 3. Bridge of the Sioux City and Pacific Railroad Company across the Missouri River. | |

C C 1.

BRIDGING GREAT KANAWHA RIVER, WEST VIRGINIA.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 16, 1883.

SIR: I have the honor to acknowledge the reference to this office of the resolution of the Senate of the United States of the 13th instant, directing the Secretary of War "to transmit to the Senate any information or reports on file in his Department, or which he may deem it proper to communicate, which will assist in showing what should be the minimum number, width, and height of spans, and their character in railroad or other bridges which may be authorized across the Great Kanawha River in West Virginia," and to report that the only information in this office bearing upon the question is contained in the inclosed copies of reports from Lient. Col. W. P. Craighill, Corps of Engineers, and his assistant, Lieut. Thomas Turtle, Corps of Engineers, made upon a communication from Mr. George W. Patton to the honorable the Secretary of War, dated May 24, 1880, requesting information relative to the necessary width and height of spans of a bridge proposed to be constructed over the Great Kanawha River at Charleston, W. Va.

It will appear from this correspondence that Colonel Craighill is of opinion that the channel span of the proposed bridge at Charleston should be not less than 250 feet in width in the clear, and that the height of the clear spans should not be less than 70 feet by the reading of the gauge at that place.

In regard to other bridges that it may become necessary to erect over the Great Kanawha, it may be said that the conditions will depend somewhat upon the location; and that with a view to the protection of navigation and commerce any law that may be enacted by Congress

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authorizing the construction of any bridge over this river should provide that drawings of the plan and location should be submitted to the Secretary of War, with a view to their examination by a Board of Engineers constituted for the purpose, and until they have been approved by the Secretary of War that the construction should not be commenced.

Very respectfully, your obedient servant,

H. G. WRIGHT,
*Chief of Engineers,
Brig. and Bvt. Maj. Gen.*

Hon. ROBERT T. LINCOLN,
Secretary of War.

REPORT OF MAJOR WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., July 26, 1880.

GENERAL: I have the honor to return herewith a letter from Mr. George W. Patton to the Secretary of War, dated May 24, 1880, in which he requests to be informed as to the proper "height" of the bridge he proposes to erect over the great Kanawha River at Charleston, and the "length of the middle span." This letter was received by me with your letter of instructions of June 4, to report my opinion as to the "propriety of erecting a bridge over the Kanawha at Charleston, and as to the character of the bridge, whether draw or otherwise, dimensions, height, width of spans, &c., that would be required for the interest of the United States and the security and convenience of navigation.

These papers were at once forwarded to Lieutenant Turtle, with directions to see Mr. Patton and to make a full investigation of the subject. I afterwards had a personal interview with Lieutenant Turtle during my visit to the Kanawha in the early part of this month.

In the present unsettled condition of the scheme for the bridge, it seems inexpedient to say more than the following:

The bridge might be erected after the proper legal conditions are complied with, provided the channel span be not less than 250 feet clear, and that the height of the clear space be not less than 70 feet by the reading of the gauge at Charleston.

Other details should be left for future discussion between the projectors of the bridge and the United States engineers, their conclusions being subject to approval by the Secretary of War, submitted through the Chief of Engineers.

In this connection it is suggested that, at the proper time, the subject be considered by a Board of Engineers, of which some of the members at least shall be those who have had experience with the question of bridging the Ohio and other western streams.

This bridge at Charleston, if erected, would probably be the first on the Great Kanawha, and its details should for that reason be the subject of very careful consideration.

I inclose Lieutenant Turtle's report of July 20, 1880, and the explanatory papers he mentions therein.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF LIEUTENANT THOMAS TURTLE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Charleston, Kanawha County, W. Va., July 20, 1880.

MAJOR: Your letter of June 7, in relation to a proposed bridge across the Kanawha, and inclosing a letter from George W. Patton, dated May 24, 1880, to the Hon. Secretary of War, and a letter from the Chief of Engineers, dated June 4, 1880, on the same subject, was duly received.

I was able to see Mr. Patton only last week, he being absent from this place.

In the mean time I collected such available information as may be useful in the future consideration of this or any other similar project on the Kanawha.

In your letter of June 7, referred to, you state, "The channel span should not, it would seem, be less than the width of our navigable pass, and should be as much more, within reasonable limits, as we can properly require."

On a straight reach and in a pool I believe that a central or channel span of from 250 to 300 feet would answer (our passes are 248 and 250 feet).

A bridge at Charleston would be in the pool, but the landing along the city front requires that the United States should not only regulate the height of the bridge, but also the position of the piers.

From the interview with Mr. Patton I learn that the project is in a very inchoate condition, and until the organization of the company is made and the location definitely proposed the position of the piers must be left for future consideration.

In referring to the height you say as follows: "The height should be regulated not only by present navigation on the Kanawha, but by what may be expected in future developments; certainly it should not be less, I should judge, than the average of bridges on the Ohio above the mouth of the Kanawha."

On page 1463 of the Report of the Chief of Engineers for 1879 General Warren gives the following data for bridges over the Ohio above the mouth of the Kanawha:

Name of bridge.	Above low water.	Above highest water.	Maximum local rise.	Width at low water of channel opening on a x is of bridge.
	Feet.	Feet.	Feet.	Feet.
Steubenville (railroad)	90	45	45	303½
Wheeling (highway)	91½	45	43½	980
Bridgeport (highway)	53	9½	43½	212
Bellaire (railroad)	90	40	50	{ 322 220
Parkersburg (railroad)	90	40	50	{ 326½ 326½

On page 35 of Warren's Report on Bridging the Mississippi he gives the following in reference to "some of the largest boats employed on the Ohio River above Cincinnati":

Name of boat.	Top of pilot-house above water.	Top of chimneys above water.
	Ft. in.	Ft. in.
Fleetwood	48 0	75 0
Telegraph	47 3	77 0
Saint Charles	47 0	68 0

I believe all these are passenger boats; the Fleetwood and Telegraph are.

I have obtained the following dimensions of the largest boats now frequenting the Kanawha:

Name of steamer.	Top of pilot-house above water.	Top of chimneys above water.
	Feet.	Feet.
Boone (passenger)	37.2	49.126
Telephone (passenger)	36.0	46.94
D. T. Lane (tow-boat)	33.25	50.75
Liberty (tow-boat)	34.88	52.62

The passenger steamers run to Gallipolis, on the Ohio River, near the mouth of the Kanawha.

I do not think that the Kanawha tow-boats will ever be made as large as those for the Ohio from Pittsburgh down. The former stream is only about half the width of the latter, and even though both rivers be improved to a 6-foot draught throughout,

the lesser width of the Kanawha will limit the sizes of tows to a less number of boats than may be taken in a fleet upon the Ohio. The largest tow coming under my observation in nearly four years consisted of 13 boats. This was with a navigable depth of 10½ feet in the channel. On the next day, with 8.7 feet in the channel, the same boat took out but 11 barges. Tows larger than these are usual on the Ohio. I have heard of tows of 26 barges, though Lieutenant Mahan (report of Chief of Engineers, 1879, p. 1315) reports no tow larger than 15 barges passing Davis Island Dam during daylight for the six months ending June 30, 1879.

I am of opinion that 45 feet for height of pilot-house and 60 feet for chimneys will be as great dimensions as will ever be found useful for boats doing general business on the Kanawha.

It will be seen that the passenger steamers on the Kanawha have their pilot-houses, in comparison with their chimneys, relatively higher than the pilot-houses of the tow-boats as well as absolutely so. This is because of the height of cabin-room required for passengers.

I inclose herewith a table showing the number of days each year that the Kanawha stood above given gauge readings from August 10, 1872, to August 10, 1879, and also the average per year for the seven years. I also inclose a sheet of cross-section paper,* on which this average is represented by a curve, the co-ordinates being the gauge readings and the average number of days per year that the gauge stood at or above the readings. The sheet of cross-section paper also shows a cross-section of the river a short distance above the public landing—the levels of low water and of the pool of the movable dam to be built below, and the levels of the recorded extraordinary floods of the Kanawha.

To require that the bridge should clear the chimneys at highest water would be prohibitory of its construction.

Considering the extent of the interests which would here be benefited by a bridge, its construction would also be prohibited by requiring that it should clear a pilot-house 45 feet in height at time of highest water.

A bridge so constructed as to require the maneuver of a draw-span whenever a boat passes is a nuisance to the traffic over it as well as to that going under it or through it.

The proper solution I consider to be the construction of a bridge of such a height that passage under it may be had except on extraordinary occasions.

Mr. Patton told me that he had thought of an elevation of 75 feet.

Calling this 75 feet on the Charleston gauge, a 45-foot pilot-house could pass under up to a gauge reading of 30 feet. From the curve and table of averages we find that this would prevent passage under it 1.57 days per year; maximum 4 days, and two years out of seven years not at all.

Mr. Patton spoke of using the bridge for passing cars across from the Elk Railroad when built to unite with the Chesapeake and Ohio. The level of 75 feet is about 25 feet higher than the track of the Chesapeake and Ohio.

I would propose, as the lowest elevation permitted, a clear height to a 70-foot gauge reading. This would permit passage under the bridge of a 45-foot pilot-house up to a gauge reading of 25 feet, prevent passage under it on an average of 2.86 days per year, with the same maximum number of days detention as the height of 75 feet, and in one year out of seven no detention at all.

The 30-foot gauge reading was attained 7 times in seven years, the 25-foot reading 13 times.

With a clear height to 70-foot gauge reading a 60-foot chimney could pass under up to a gauge reading of 10 feet; such a chimney could not pass under on an average of thirty-nine days per year.

The chimneys of the Liberty, the highest of any now on the Kanawha, could pass under up to a gauge reading of 17 feet; they would be prevented from passing under on less than ten days per year.

The pilot-house of the Boone, the highest now on the river, could pass under such bridge with the gauge reading 32 + feet, and would be prevented from doing so on one day in a year.

My observation is that boats do not run on the rise of extreme stages; the danger from driftwood, and in the case of tow-boats the difficulty of managing the fleets, rendering it advisable to await the falling stage.

The letters from the Chief of Engineers and Mr. George W. Patton are returned herewith.

Very respectfully,

THOMAS TURTLE,
First Lieut. of Engineers.

Maj. WM. P. CRAIGHILL,
Corps of Engineers.

* Omitted. Printed in Senate Ex. Doc. No. 73, Forty-seventh Congress, second session.

Table showing number of days each year that river stood above given gauge readings, from August 10, 1872, to August 10, 1879.

Height.	August 10, 1872, to August 10, 1873.	August 10, 1873, to August 10, 1874.	August 10, 1874, to August 10, 1875.	August 10, 1875, to August 10, 1876.	August 10, 1876, to August 10, 1877.	August 10, 1877, to August 10, 1878.	August 10, 1878, to August 10, 1879.	Totals for seven years.	Average for seven years.
2 feet.....	330	354	349	306	865	347	358	2,469	352.70
3 feet.....	295	295	304	342	328	308	327	2,199	314.14
4 feet.....	249	238	275	285	264	276	274	1,861	265.86
5 feet.....	194	172	226	237	185	230	225	1,460	209.86
6 feet.....	159	123	178	172	142	179	164	1,117	159.57
7 feet.....	135	81	185	119	96	130	123	819	117.00
8 feet.....	107	60	91	68	54	77	81	538	76.86
9 feet.....	85	46	61	88	42	48	54	374	53.43
10 feet.....	66	29	43	23	35	34	43	273	39.00
11 feet.....	61	23	31	15	24	29	34	217	31.00
12 feet.....	52	20	26	10	20	18	25	171	24.43
13 feet.....	41	16	20	6	18	16	23	140	20.00
14 feet.....	35	14	18	3	15	11	20	116	16.57
15 feet.....	31	11	16	1	14	7	14	94	13.43
16 feet.....	25	10	15		13	6	13	82	11.71
17 feet.....	19	9	12		12	4	12	68	9.71
18 feet.....	15	8	9		12	3	11	68	8.29
19 feet.....	12	6	9		10	3	11	51	7.29
20 feet.....	10	5	8		6	3	9	41	5.86
21 feet.....	8	4	6		5	2	8	33	4.71
22 feet.....	7	4	6		5	2	6	30	4.29
23 feet.....	6	4	5		4	2	5	26	3.71
24 feet.....	4	3	4		4	2	5	22	3.14
25 feet.....	4	3	4		3	2	4	20	2.86
26 feet.....	3	3	4		3	2	3	18	2.57
27 feet.....	3	3	4		3	1	3	17	2.43
28 feet.....	1	2	4		2	1	3	13	1.86
29 feet.....		2	4		2	1	3	12	1.71
30 feet.....		1	4		2	1	3	11	1.57
31 feet.....		1	3		2	1	2	9	1.29
32 feet.....			2		2	1	2	7	1.00
33 feet.....			2		2	1	2	7	1.00
34 feet.....			1			1	2	4	0.57
35 feet.....			1			1	2	4	0.57
36 feet.....			1				2	3	0.43

LOWEST WATER.—October 2, 1872, 1.50 feet; October 18 and 19, 1.90 feet; September 18, 1.30 feet; September 18, 2.34 feet; August 9, 1877, 2.11 feet; September 6, 1877, 1.50 feet; July 26, 1879, 1.50 feet.

C C 2.

PILE AND PONTON BRIDGE ACROSS THE MISSISSIPPI RIVER AT DUBUQUE, IOWA.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., August 11, 1882.

SIR: Referring to your letter of the 6th ultimo, submitting to the Hon. the Secretary of War certain papers required by him in the matter of the pile and ponton bridge proposed to be erected over the Mississippi River by the East Dubuque Bridge Company between the cities of Dubuque, Iowa, and East Dubuque, Ill., which has been referred to this office, I am directed by the Secretary of War to transmit for the information of the bridge company the inclosed copy of a report from Maj. A. Mackenzie, Corps of Engineers, dated July 31, 1882, with re-

quest that the modifications proposed by him be adopted by the company and carried out in the construction of the bridge, and that the company signify its acceptance of the same in writing.

The certificate of the incorporation of the bridge company is herewith returned as requested.

Very respectfully, your obedient servant,

H. G. WRIGHT,
Chief of Engineers,
Brig. and Bvt. Maj. Gen.

R. E. ODELL, Esq.,
Secretary East Dubuque Bridge Company, East Dubuque, Ill.

REPORT OF MAJOR ALEXANDER MACKENZIE, CORPS OF ENGINEERS-

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 31, 1882.

GENERAL: As instructed by your indorsement dated July 12, 1882, I have the honor to submit the following report upon the plan and specifications for a ponton bridge at Dubuque, Iowa, submitted July 6 to the Hon. Secretary of War by R. E. Odell, secretary of the East Dubuque Bridge Company.

The location proposed for the ponton bridge immediately below the railroad bridge is the best that could be chosen, and if properly built and managed in such location the proposed bridge will be no material obstruction to navigation.

I would propose the following modifications in the plan submitted:

First modification.—The sixth span from the Iowa shore, which is directly below a span of the railroad bridge, sometimes used by rafts, should give the same clear water-way as the corresponding span in the railroad bridge, which latter span is 225 feet between centers of abutments. By the plan submitted the sixth span, above referred to, is made 200 feet. It should be about 215 feet.

Second modification.—The west ponton span is made, by plan and specifications submitted, to give clear opening of 365 feet. This is not sufficient to cover fully the west draw opening and west raft span in the railroad bridge. This ponton should be increased in length sufficiently to fully correspond with openings above, which would give it a length of about 410 feet.

The modifications proposed are such as will make all the booms connecting the two bridges approximately parallel with the direction of the current and the long pier of the railroad bridge.

Booms are shown in the plan but not referred to in the specifications. Those connecting the bridges are proper; those shown as located above railroad bridge would probably require slight modification of direction, which the bridge company would adopt for safety when construction was undertaken.

The act of March 3, 1875, under which this ponton bridge is to be built, requires a suitable ponton draw of not less than 500 feet in width. The plan presented does not comply with this requirement, but with the location selected any increase of width over that suggested in my second modification would be of no advantage to navigation and might be injurious. If the ponton bridge were to be located at a distance from the railroad bridge the increased width of 500 feet would be necessary, but

as the two bridges form in fact one structure, a correspondence in width of openings is desirable.

The act of March 3, 1875, is full and complete as regards the right of the Secretary of War to call for changes and modifications required in the interest of navigation at any time. This is of importance, as while, from all that can be now seen, the plans submitted with modifications suggested protect fully the interests of navigation, there may arise in the future a necessity for changes or additional work.

The description of the Dubuque Railroad Bridge is found in Warren's Bridging the Mississippi River, page 90, and the Report of a Board of Engineers on Dubuque and Dunleith Ponton Bridge, in Report of the Chief of Engineers for 1876, Part II, page 308.

It is possible certain private interests might be affected by the shore spans of the proposed bridge, and the shoal water below the bridge on the East Dubuque side might be made shoaler, but these matters would probably be settled by the interested parties; and my report, as I presume is proper, is only intended to consider the plans and location of the bridge as it affects through navigation.

The papers submitted to me with your indorsement of July 12 are returned.

I am, very respectfully, your obedient servant,

A. MACKENZIE,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

LETTER OF THE EAST DUBUQUE BRIDGE COMPANY TO THE CHIEF
OF ENGINEERS ACCEPTING THE MODIFIED PLAN.

OFFICE OF EAST DUBUQUE BRIDGE COMPANY,
East Dubuque, Ill., August 21, 1882.

SIR: Your esteemed favor of 11th instant inclosing Maj. A. Mackenzie's report and plan of pile and ponton bridge at this place, with modifications, has been received.

At a meeting of the board of directors of the East Dubuque Bridge Company held this day, the modified plan was unanimously adopted, as shown by the inclosed proceedings of our board.

Very respectfully, your obedient servant,

R. E. ODELL,

Secretary of East Dubuque Bridge Company.

General H. G. WRIGHT,
Chief of Engineers, &c.

[First indorsement.]

WAR DEPARTMENT, *October 19, 1882.*

Respectfully referred to the Chief of Engineers, inviting attention to the second section of the act of March 3, 1875 (18 Stat., part 3, page 522), with request that this paper be submitted for the action of the Secretary of War, with the modified plans of the bridge and the recommendation of the Chief of Engineers.

By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

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[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 25, 1882.

Respectfully returned to the Hon. the Secretary of War with letter of this date herewith.

H. G. WRIGHT,
*Chief of Engineers,
Brig. and Bvt. Maj. Gen.*

[Third indorsement.]

Respectfully returned to the Chief of Engineers.

It is not within the authority of the Secretary of War to change the positive requirements of the act, which is that the ponton draw shall not be less than 500 feet in width.

By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

WAR DEPARTMENT, October 27, 1882.

RESOLUTION ADOPTED BY BOARD OF DIRECTORS OF THE EAST DUBUQUE BRIDGE COMPANY.

EAST DUBUQUE, ILL., August 21, 1882.

At a special meeting of the East Dubuque Bridge Company, held August 21, 1882, the following resolution was adopted:

Resolved, That the modified plan of the pile and ponton bridge as submitted to this company by Maj. A. Mackenzie in his report of July 31, 1882, be, and is hereby, accepted and adopted as the plan of this company for said bridge; and the Chief Engineer is requested to report accordingly to the Hon. Secretary of War, and ask him to issue permission to build said bridge at once.

CHAS. S. BURT,
President.

R. E. ODELL,
Secretary.

LETTER OF THE CHIEF OF ENGINEERS TO THE HON THE SECRETARY OF WAR.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., October 25, 1882.

SIR: In reply to instructions by indorsement of the 19th instant, returning to this office the communication of August 21 last from R. E. Odell on behalf of the East Dubuque Bridge Company, and directing its return with the modified plans of the bridge and recommendations of the Chief of Engineers, I have the honor to submit the following modifications of the plan and specifications submitted July 6, 1882, to the honorable the Secretary of War by R. E. Odell, secretary of the East Dubuque Bridge Company, for a ponton bridge at Dubuque, Iowa, recommended by the Chief of Engineers August 4, 1882, and unani-

mously adopted August 21, 1882, by the board of directors of said company, viz:

First modification.—The sixth span from the Iowa shore, which is directly below a span of the railroad bridge some time used by rafts, should give the same clear water-way as the corresponding span in the railroad bridge; which latter span is 225 feet between centers of abutments. By the plan submitted the sixth span above referred to is made 200 feet. It should be about 215 feet in the clear.

Second modification.—The west ponton span is made, by plan and specifications submitted, to give a clear opening of 365 feet. This is not sufficient to cover fully the west draw opening and west raft span in the railroad bridge. This ponton should be increased in length sufficiently to fully correspond with openings above, which would give it a length of about 410 feet.

The plan submitted July 6, 1882, by the East Dubuque Bridge Company, and also a drawing of the modifications thereto as above described, are submitted herewith.

The act of March 3, 1875, authorizing the construction of this bridge, requires that the main ponton draw shall not be less than 500 feet wide, while that proposed by the plan as modified is only about 410 feet. This last named width is all that is required for easy and safe navigation, and is probably more desirable than the greater width named in the law. This is the view taken by Maj. A. Mackenzie, Corps of Engineers, in his report of July 31, 1882, in which I concurred, but further consideration leads to doubt whether the authority given in the act to the Secretary of War to call for changes and modifications required in the interest of navigation really extends to a diminution of the span, as Major Mackenzie supposes. The attention of the Secretary of War is therefore invited to this point.

Very respectfully, your obedient servant,

H. G. WRIGHT,
*Chief of Engineers,
Brig. and Bvt. Maj. Gen.*

Hon. ROBERT T. LINCOLN,
Secretary of War.

LETTER OF THE HON. THE SECRETARY OF WAR TO COLONEL D. B. HENDERSON.

WAR DEPARTMENT,
Washington City, October 30, 1882.

DEAR SIR: Upon your request I have again given careful consideration to the papers relating to the ponton bridge across the Mississippi River at Dubuque.

I regret very much that I cannot accede to your urgent request to authorize the construction of the bridge under the plan submitted. The only difficulty is in the matter of the width of the main draw. This draw, according to the plan, is 410 feet in width, and it is stated by the Chief of Engineers that this width is all that is required for easy and safe navigation, and is probably more desirable than the greater width named in the law. I would have no hesitation in concurring in the views of the Chief of Engineers, but the second section of the act authorizing the bridge (approved March 3, 1875) says explicitly that "the bridge shall be constructed with a suitable ponton draw, of not less

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than five hundred feet in width, located over the main channel of the river." This is the only specific requirement as to dimensions, &c. made in the act, and it is entirely without my authority to make any change in that regard.

I think, however, that there would be no difficulty in procuring from Congress an amendment in that particular. Congress will meet in a little more than a month from now, and as the matter has rested without action for more than seven years it seems to me no great harm can come from its resting a short time longer.

If it is desired, it will give me great pleasure upon the reassembling of Congress to address a communication to the proper committees of the Senate and House, recommending that the words "five hundred" in the second section of the act shall be amended to read "four hundred."

Regretting the conclusion to which I am compelled to come,

I am, very truly, yours,

ROBERT T. LINCOLN,
Secretary of War.

Col. D. B. HENDERSON,
*Secretary Republican Congressional Committee,
Washington, D. C.*

LETTER OF THE EAST DUBUQUE BRIDGE COMPANY TO THE HON.
THE SECRETARY OF WAR, SUBMITTING NEW PLAN AND SPECIFICATIONS.

EAST DUBUQUE, ILL., *November 22, 1882.*

SIR: Referring to your letter dated October 30, addressed to the Hon. D. B. Henderson, concerning the pile and ponton bridge across the Mississippi River at this place, the East Dubuque Bridge Company, after a deliberate and careful consideration of the matter, has decided to submit to you for your consideration and approval a new plan and specification for said bridge.

The proposed change, we trust, you will find unobjectionable and fully up to the letter and spirit of the law.

Your early consideration is respectfully solicited.

Very respectfully, your obedient servant,

R. E. ODELL,
Secretary East Dubuque Bridge Company.

Hon. ROBT. T. LINCOLN,
Secretary of War.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
December 1, 1882.

Respectfully referred to Maj. A. Mackenzie, Corps of Engineers, for report.

In this connection attention is asked to Department letter of November 7, 1882.

To be returned. By command of Brigadier-General Wright.

JOHN G. PARKE,
*Lieut. Col. of Engineers,
Bvt. Maj. Gen., U. S. A.*

[Second indorsement.]

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., December 8, 1882.

Respectfully returned to the Chief of Engineers, U. S. A., with my letter of this date.

A. MACKENZIE,
Major of Engineers.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
 U. S. ARMY,
December 13, 1882.

Respectfully returned to the honorable the Secretary of War, inviting attention to the report thereon of Maj. A. Mackenzie, Corps of Engineers, to whom it was referred, from which it will appear that, in his opinion, the new plans and specifications proposed by the company for the bridge are not as good as those presented in his (Major Mackenzie's) report of July 31, 1882, which, in his judgment, will best secure the interest of navigation. He suggests that the difficulties in the case be overcome by securing a modification of the act of March 3, 1875, authorizing the construction of the bridge, striking out from section 2 the words "that the bridge shall be constructed with a suitable ponton draw, of not less than five hundred feet in width, located over the main channel of the river," and substituting therefor the words "that the bridge shall be constructed with ponton draws of such length and location as shall be ordered by the Secretary of War."

Major Mackenzie's views are concurred in, and it is recommended that the attention of the bridge company be called to the subject, with the view to securing the suggested legislation.

H. G. WRIGHT,
*Chief of Engineers,
 Brig. and Bvt. Maj. Gen.*

[Fourth indorsement.]

The Secretary of War concurs in the views of the Chief of Engineers and Major Mackenzie.

By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

WAR DEPARTMENT, *December 15, 1882.*

REPORT OF MAJOR ALEXANDER MACKENZIE, CORPS OF ENGINEERS,
 OF DECEMBER 8, 1882.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., December 8, 1882.

GENERAL: As instructed by your indorsement dated December 1, 1882, on letter of R. E. Odell, Secretary East Dubuque Bridge Company, to the Hon. Secretary of War, dated November 22, 1882, I have the honor to report as follows: That in my opinion the new plans and specifications for the Dubuque ponton bridge presented to the Hon. Secretary of War by R. E. Odell, Secretary, under date of November 22, 1882, are not as good as the plans presented in my report dated July 31, 1882.

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The later plans of the bridge company include a pier 200 feet below the west draw-rest pier of the railroad bridge, which might prove a dangerous obstruction to rafts.

The act of March 3, 1875, which authorized the construction of the Dubuque ponton bridge, required a suitable ponton draw of not less than 500 feet in width, and was evidently intended to give not less than 500 feet clear water-way. Considering the proposed location of ponton bridge immediately below the railroad bridge this clear water-way cannot be given, whether use is made of two pontons aggregating about 810 feet in length, as originally proposed, or one ponton 510 feet long, as now proposed. As I believe the plans and location as given in my report of July 31, 1882, are such as will best secure the interests of navigation, I would respectfully recommend that they be adhered to.

The difficulty placed in the way of construction by the wording of the original act can be easily overcome by such legislation as will modify the act of March 3, 1875, by striking out from section 2 the words "*That the bridge shall be constructed with a suitable ponton draw of not less than five hundred feet in width, located over the main channel of the river,*" and substituting the words "*That the bridge shall be constructed with ponton draws of such length and location as shall be ordered by the Secretary of War.*"

Very respectfully, your obedient servant,

A. MACKENZIE,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS TO THE HON. THE SECRETARY OF WAR.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 2, 1883.

SIR: I have to acknowledge the reference to this office on the 22d ultimo of the letter of the chairman of the Committee on Commerce of the Senate of the United States of the 19th ultimo, inclosing Senate bill 2358 "to amend an act entitled 'An act to authorize the construction of a ponton wagon-bridge across the Mississippi River at or near the city of Dubuque, in the State of Iowa,'" and in compliance with your instructions to report that it was referred to Maj. A. Mackenzie, Corps of Engineers, who has returned it with indorsement, of which the following is a copy:

The amendment as proposed in Senate bill 2358, herewith, would seem to be satisfactory as permitting, under the direction of the Secretary of War, the construction of the Dubuque ponton bridge in accordance with plans proposed in my letter of July 31, 1882 (shown on the tracing accompanying this paper), which duly protect the interests of navigation.

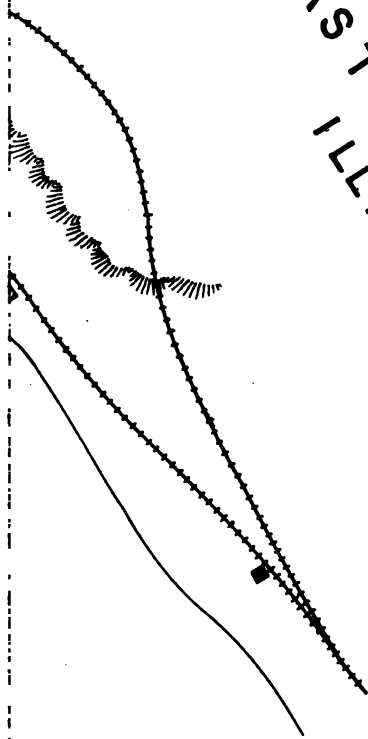
I concur in his views. The letter of the chairman of the Committee on Commerce and accompanying papers are herewith returned.

Very respectfully, your obedient servant,

H. G. WRIGHT,
*Chief of Engineers,
Brig. and Bvt. Maj. Gen.*

Hon. ROBERT T. LINCOLN,
Secretary of War.

EAST DUBUQUE
ILL.



C C 3.

PROPOSED BRIDGE OF THE SIOUX CITY AND PACIFIC RAILROAD COMPANY ACROSS THE MISSOURI RIVER.

NEW YORK, *July 1, 1882.*

DEAR SIR: I submit for your examination and approval the plans of a proposed bridge across the Missouri River at the present crossing of the Sioux City and Pacific Railroad, which bridge is to be built under the authority given by act of Congress approved June 27, 1882.

I remain, very respectfully, yours,

GEO. S. MORISON,
Engineer of Sioux City and Pacific Bridge.

HON. ROBERT T. LINCOLN,
Secretary of War.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
July 10, 1882.

Respectfully referred to Maj. C. R. Suter, Corps of Engineers, for early report.

Copy of act authorizing bridge herewith.
To be returned.

JOHN G. PARKE,
Acting Chief of Engineers.

[Second indorsement.]

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., July 15, 1882.

Respectfully returned to the Chief of Engineers.

I have examined the map and drawing submitted by the engineer of the bridge company, and am of opinion that the projected bridge conforms in its details to the requirements of the act authorizing its construction, and that if the channel is regulated as indicated on the bridge company's map no unnecessary impediment to navigation will ensue.

CHAS. R. SUTER,
Major of Engineers.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
July 21, 1882.

Respectfully returned to the Hon. the Secretary of War, inviting attention to the foregoing indorsement of Maj. C. R. Suter, Corps of Engineers, to whom it was referred, in whose views I concur.

The within plans are recommended for approval accordingly.

H. G. WRIGHT,
*Chief of Engineers,
Brig. and Bvt. Maj. Gen.*

[Fourth indorsement.]

WAR DEPARTMENT, *July 29, 1882.*

Respectfully returned.

The plans are approved as recommended by the Chief of Engineers.
By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

LETTER OF THE CHIEF OF ENGINEERS TO MAJOR CHARLES B. SUTER,
CORPS OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., August 1, 1882.

SIR: The Secretary of War has approved the plan of the bridge submitted by Mr. George S. Morison, engineer of Sioux City and Pacific Railroad Bridge, upon which you reported on the 15th ultimo.

The title of the act authorizing the bridge, approved June 27, 1882, is as follows:

An act authorizing the Sioux City and Pacific Railroad Company to construct and maintain a railroad bridge over the Missouri River.

You will please exercise, as far as practicable, without incurring expense, such supervision over the bridge during its construction as will enable you to report whether it is located and being constructed conformably to the requirements of the act and to the approved plan.

By command of Brigadier-General Wright.

Very respectfully, your obedient servant,

H. M. ADAMS,
Captain of Engineers.

Maj. C. R. SUTER,
Corps of Engineers.

C C 4.

BRIDGES OF THE TEXAS AND SAINT LOUIS RAILWAY COMPANY ACROSS
OUACHITA RIVER, AT CAMDEN, ARKANSAS, AND ACROSS ARKANSAS
RIVER NEAR PINE BLUFF, ARKANSAS.

TEXAS AND SAINT LOUIS RAILWAY COMPANY,
CHIEF ENGINEER'S OFFICE,
Pine Bluff, Ark., September 23, 1882.

SIR: I have the honor to submit, for the approval of the Secretary of War, plans and maps showing the design and location of bridges proposed to be built across the Ouachita and Arkansas rivers by the Texas and Saint Louis Railway Company under the act approved June 27, 1882.

Very respectfully,

C. F. STEPHENS,
Chief Engineer, Texas and Saint Louis Railway.
Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 5, 1882.

Respectfully referred to Capt. T. H. Handbury, Corps of Engineers, for examination and report.

The act referred to will be found in General Orders, A. G. O., No. 79; copy sent you August 20.

To be returned.

By command of Brigadier-General Wright.

JOHN G. PARKE,
Lieut. Col. of Engineers,
Bvt. Maj. Gen., U. S. A.

[Second indorsement.]

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., October 20, 1882.

Respectfully returned to the Chief of Engineers, U. S. A., with report of this date.

THOS. H. HANDBURY,
Captain, Corps of Engineers.

REPORT OF CAPTAIN THOMAS A. HANDBURY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., October 20, 1882.

GENERAL: To comply with your indorsement dated October 5, 1882, on the letter of Mr. C. F. Stephens, chief engineer Texas and Saint Louis Railway, referring to me for examination and report the plans and maps showing the design and location of bridges proposed to be built across the Ouachita and Arkansas rivers by the Texas and Saint Louis Railway Company, under act of Congress approved June 27, 1882, which had been submitted by him for the approval of the Secretary of War, I have the honor to report as follows:

On the 16th instant, in company with Mr. Stephens, the chief engineer of the Texas and Saint Louis Railway Company, I visited Camden, Ark. Near that place, on the line of this railroad, we crossed the Ouachita River on a bridge located and built as shown in the drawings submitted to you. The location of the bridge and the direction of its axis in regard to that of the current of the river seem to be unobjectionable and in accordance with the requirements of the law authorizing the construction of a bridge at this point.

The bridge proper consists of but one span, with long trestle approaches, as shown. This span is a pivot or draw. The pivot pier consists of a central iron cylinder, 6 feet diameter, surrounded by six like cylinders 4 feet diameter. These are filled with concrete and rest on a bed of lignite 24 feet below the bottom of the river. The distance from out to out of this cluster is 26 feet. The abutment piers are made of piles driven into the bank and incased with heavy planking. There are no draw rests.

The upper and lower chords of the bridge, and the tension members are iron. The compression members are wood. Proper machinery is provided for opening the draw by hand. The lower chord is 10.6 feet above the high water of 1844, which, at the time the elevation of the

bridge was decided upon, was regarded as extreme high water. Last spring, however, the water rose 2 feet above the high water of 1844.

The clear openings on each side of the pivot pier are 110 feet.

The second section of the law reads:

* * * And if the bridges, or either of them, over the said Saline, Ouachita, and Red rivers shall be constructed as draw or pivot bridges, the draw or pivot pier shall be over the main channel of the river at an accessible navigable point, and the openings on each side of the pivot pier shall not be less than one hundred and thirty feet in the clear unless otherwise expressly directed by the Secretary of War, and if so directed shall be according to such direction. * * *

Whether in the exercise of this discretion, the Secretary of War has authorized the construction of this draw with clear openings of but 110 feet, I have not been informed.

The gauge of the Texas and Saint Louis Railroad is 3 feet.

With regard to the "bridge across the Arkansas River near Pine Bluff," this has been in process of construction since as early as last June, and is not yet completed. The piers are nearly all down to foundation and carried above the present stage of water. I have visited the locality and examined the location of the bridge and the direction of its axis with reference to that of the current of the river at the stage which is most important for navigation, and find that these are well selected and so as to form the least obstruction to the navigation.

The proposed site for the draw or pivot will be over the main channel of the river at an accessible navigable point, as the law requires. The bridge thus far is being built in accordance with the drawings submitted to you by Mr. Stephens, and, if so continued to completion, will fulfill all the requirements of the law authorizing its construction.

The only question upon which any doubt might arise is as to its location. The law referred to authorizes the Texas and Saint Louis Railway Company to construct and maintain a bridge and approaches thereto over the Arkansas River, in Jefferson County, in the State of Arkansas, near the city of Pine Bluff. This bridge is being built at a point 10 miles below. So far as it affects the navigation of the river, its present site is more favorable than any that might have been selected at or in the more immediate vicinity of Pine Bluff.

If the selection of the site at a point so distant from that mentioned in the act is no valid objection the construction of the bridge in accordance with the plans submitted can safely be authorized.

The letter of Mr. C. F. Stephens, chief engineer Texas and Saint Louis Railway, to the Chief of Engineers, U. S. A., and the accompanying drawings are herewith returned.

Very respectfully, your obedient servant,

THOS. H. HANDBURY,
Captain, Corps of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS TO THE HON. THE SECRETARY OF WAR.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., October 31, 1882.

SIR: I have the honor to submit herewith a letter of September 23, 1882, from C. F. Stephens, chief engineer Texas and Saint Louis Railway Company, transmitting for approval a drawing showing the plan

and location of a railroad bridge across Ouachita River near Camden, Ark., and one of the plan and location of a railroad bridge across Arkansas River near Pine Bluff, together with a report thereon from Capt. T. H. Handbury, Corps of Engineers, to whom they were referred for examination.

The provisions of the sixth section of the act of June 27, 1882, authorizing the construction of these bridges, have not been complied with in so far that they were located before the required approval of their construction was obtained. They were in fact begun and partly finished before the passage of the act.

As it appears, however, that the plan and location of the bridge across the Arkansas at Pine Bluff conform to the requirements of the above act, I would respectfully recommend that its construction be approved.

As regards the bridge across the Ouachita at Camden, the second section of the above act requires that the opening on each side of the pivot pier shall, for bridges across Ouachita, be not less than 130 feet in the clear. The opening on each side of the pivot pier of this bridge as now built is but 110 feet, and it is submitted whether this departure from the conditions imposed is not sufficient to justify the withholding of the required approval of its plan and location.

Very respectfully, your obedient servant,

H. G. WRIGHT,
Chief of Engineers,
Brig. and Bvt. Maj. Gen.

Hon. ROBERT T. LINCOLN,
Secretary of War.

[First indorsement.]

Respectfully returned to the Chief of Engineers, inviting attention to that part of section 2 of the act of June 27, 1882, following the words "and the opening on each side of the pivot pier shall be not less than 130 feet in the clear," viz: "unless otherwise expressly directed by the Secretary of War, and if so directed shall be according to such direction," &c.

This language seems to leave the matter of the width to be determined by the Secretary of War, and in view thereof the recommendation of the Chief of Engineers is requested as to the proper width of the openings on each side of this pivot pier of the bridge over the Ouachita at Camden, Ark.

By order of the Secretary of War.

C. H. CARRINGTON,
Acting Chief Clerk.

WAR DEPARTMENT, November 3, 1882.

REPORT OF CAPTAIN THOMAS H. HANDBURY, CORPS OF ENGINEERS,
OF APRIL 7, 1883.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., April 7, 1883.

GENERAL: I have the honor to acknowledge the receipt of your communication of the 2d instant calling my attention to the fact that your office was without a reply to your instructions to me of the 8th of November last, with reference to certain additional information required

regarding the Texas and Saint Louis Railroad Company's bridge over the Ouachita River near Camden, Ark.

In reply I have the honor to state that immediately upon the receipt of the instructions of November 8, I addressed a communication to the manager of the principal line of steamers plying upon the Ouachita River with the view to obtaining an expression of opinion from the steamboat men as to what should be the proper width of the opening on each side of the pivot pier of the bridge over the Ouachita at Camden. To this communication I have as yet received no reply.

At the same time I also wrote to Mr. C. F. Stephens, chief engineer Texas and Saint Louis Railway Company, for information as to why the draw openings of this bridge were not made 130 feet in the clear as the law requires, instead of 110 feet as built. His reply was:

The reason that this bridge was constructed of clear openings of 110 feet instead of 130 feet, was that a space of 250 feet, allowing openings of 110 feet on each side of the pivot pier, reaches across the whole river, the abutments being on dry ground at an ordinary stage of water. It was, therefore, deemed unnecessary to build a bridge of greater span.

I inclose herewith a tracing from a copy of the drawings of this bridge furnished me by Mr. Stephens. An examination of this will show that if a pivot draw is to be provided, with a passage way on each side for steamers, as contemplated by the act authorizing the construction of a bridge at this point, all the space practicable to be left has been provided for, as the bridge is now built.

Whether this space of 110 feet is sufficient for the accommodation, without undue detention and danger, of such steamers, rafts, and crafts of various kinds as may have occasion to pass the bridge is, I think, a matter of great doubt. At present the amount of commerce passing this point on the Ouachita River is very limited, but it has been and no doubt will again be quite considerable. The opening provided is certainly not as large as the interests of this commerce have a right to demand.

Section 4 of the act approved June 27, 1882, authorizing the construction of a bridge over the Ouachita River at Camden, provides—

That no bridge shall be erected or maintained under the authority of this act which shall at any time substantially or materially obstruct the free navigation of said rivers; and if any bridge erected under such authority shall, in the opinion of the Secretary of War, obstruct such navigation, he is hereby authorized to cause such change or alteration of said bridge or bridges to be made as will effectually obviate such obstructions, and all such alterations shall be made and all such obstructions be removed at the expense of the owner or owners of said bridge.

Were the present bridge so altered as to locate the pivot pier near or on either shore, providing but one opening, a space of 130 feet, or even the whole width of the river, might easily be made available for the passage of boats.

In my judgment one opening of 130 feet would be preferable under the circumstances to two of 110 feet each, and any bridge that contemplates a less clear opening than 130 feet should not receive the approval of the Secretary of War.

Before the completion of the Cairo and Fulton Railroad, now the Saint Louis, Iron Mountain and Southern, Arkadelphia, Ark., 75 miles above Camden, and the head of navigation on the Ouachita River, was a point from which from eight to ten thousand bales of cotton per year were shipped by river to market. Camden was another large shipping point. As much as forty thousand bales a year were sent from here. Large quantities of supplies were returned to the country by the same

means. Large boats ran regularly during the boating season from Camden to New Orleans and Saint Louis.

One of these drew as much as 8.5 feet of water, was 250 feet long and 67.5 feet wide over all. So important was this commerce that at one time a system of slackwater navigation was projected for this river in order to secure navigation throughout the whole year. With the advent of railroads into this section of the country the river commerce declined, and is now much less than it was formerly, especially in that portion of the river above Camden. With the future developments of the country, however, it is natural to suppose that the river commerce will again assume importance. In that event, the abandoned project for slackwater navigation will naturally be revived. However we look at the subject, any bridge across the river is a factor of considerable importance to its navigation.

In view of the fact that there is at present but a very limited commerce passing this bridge on the Ouachita River, and that to change it in accordance with the above suggestions would be attended with considerable expense and great inconvenience to the railroad company, which is pushing its road through an undeveloped country, I would submit that I can see no objection to the matter remaining in abeyance until such time as increased commerce demands that the change should be made. In the mean time the bridge will be but one of a numerous class built over navigable streams throughout the country without law or authority from the General Government.

Very respectfully, your obedient servant,

THOS. H. HANDBURY,
Captain, Corps of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS TO THE HON. THE SECRETARY
OF WAR.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., April 16, 1883.

SIR: Referring to letter from this office of October 31, 1882, submitting letter from C. F. Stephens, chief engineer of the Texas and Saint Louis Railway Company, transmitting for approval drawings showing plan and location of a railroad bridge across the Ouachita River near Camden, Ark., and of a railroad bridge across Arkansas River near Pine Bluff, together with report thereon from Capt. Thomas H. Handbury, Corps of Engineers, &c.; and to the indorsement of the Secretary of War dated November 3, 1882, returning it to this office, requesting recommendation of the Chief of Engineers in regard to proper width of draw openings on each side of the pivot pier of the bridge over the Ouachita at Camden, I have the honor to report that the papers were referred to Capt. Thomas H. Handbury, Corps of Engineers, November 8, 1882, and have been returned with report of 7th instant, which is herewith submitted.

It will be seen that the whole width of the river at Camden is but 250 feet, and it would not, therefore, be practicable to make draw openings on each side of the pivot pier 130 feet in width, as required by the act of June 27, 1882. The pivot pier might have been so constructed as

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to give a width of 130 feet, or more, on one side, which would have obstructed the navigation much less than the two openings of 110 feet each adopted by the railroad company.

In view of the fact that there is, as stated by Captain Handbury, but a very limited commerce passing this bridge, and that a change as suggested by him would involve great expense and inconvenience to the railroad company, I concur in his opinion that it would be better to leave the matter as it stands for the present, and until such time as the interests of commerce may demand greater facilities for passing than are now afforded.

The bridge at Pine Bluff, over the Arkansas River, having been constructed in accordance with the provisions of law, is recommended for approval.

Previous papers are herewith.

Very respectfully, your obedient servant,

H. G. WRIGHT,
*Chief of Engineers,
Brig. and Bvt. Maj. Gen.*

HON. ROBERT T. LINCOLN,
Secretary of War.

[First indorsement.]

Approved.

ROBERT T. LINCOLN,
Secretary of War.

WAR DEPARTMENT, April 21, 1883.

C C 5.

BRIDGE ACROSS LAKE CHAMPLAIN FROM ALBURGH, VERMONT, TO ROUSE'S POINT, NEW YORK; AND BRIDGE ACROSS MISSISQUOI BAY BETWEEN THE TOWNS OF SWANTON AND ALBURGH, VERMONT.

WASHINGTON, D. C., February 21, 1883.

SIR: I herewith submit plans and maps appertaining to the bridging of Lake Champlain at Rouse's Point and Alburgh, Vt., for approval, &c.
Respectfully,

A. B. JEWETT,
Director R. R.

To the SECRETARY OF WAR.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
February 24, 1883.

Respectfully returned to the honorable the Secretary of War.

The drawings submitted conform to the requirements of the law, with the exception of that portion relating to the direction and strength of currents. This last condition is impracticable, as well as unimportant, inasmuch as the currents depend mainly for their direction and strength upon the direction and force of the wind. In calm weather the current is scarcely appreciable in Missisquoi Bay, while in the channel-way op-

posite Rouse's Point there is a gentle current to the north. Whatever bearing this current may have upon the navigation in connection with the drawbridge at this point, it will not be modified in any important degree by the proposed bridge, inasmuch as its draw openings are to be in continuation of the draw openings of the existing bridge, thus constituting practically a single draw.

I therefore think the plans and locations of the bridges may be properly approved by the Secretary of War, and I recommend accordingly.

A copy of the act, certified at the Department of State, is herewith.

H. G. WRIGHT,
Chief of Engineers,
Brig. and Bvt. Maj. Gen.

[Second indorsement.]

WAR DEPARTMENT, *February 24, 1883.*

Approved.

ROBERT T. LINCOLN,
Secretary of War.

APPENDIX D D.

IMPROVEMENT OF HARBOR AT DULUTH, MINNESOTA, AND OF THE ENTRANCE TO SUPERIOR BAY, LAKE SUPERIOR—IMPROVEMENT OF THE HARBOR AT GRAND MARAIS, MINNESOTA.

REPORT OF MAJOR CHARLES J. ALLEN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|--------------------------------------|---------------------------------------|
| 1. Harbor at Duluth, Minnesota. | 3. Harbor at Grand Marais, Minnesota. |
| 2. Dredging Superior Bay, Wisconsin. | |
-

(For letter of transmittal, see Appendix X.)

D D 1.

IMPROVEMENT OF HARBOR AT DULUTH, MINNESOTA.

The present project as to dredging is based upon the report and estimates of a Board of Engineers convened in January, 1881, and contemplates the maintenance of the existing dredged areas and enlargement of the harbor by dredging, as follows, viz:

1. On a line from Rice's to Minnesota Point;
2. On a line from the blast-furnace docks to intersect with the channel of the Saint Louis River;
3. On a line parallel to Minnesota Point; and,
4. Along the west side of Rice's Point, in Saint Louis Bay.

The dredging to provide for a depth of 16 feet at low water.

The cost of the project, including the item of \$25,000 for maintenance of the canal piers for the present, as given in Annual Report, 1881, is placed at \$212,988.36.

For original projects and history of the work to 1879, see pages 1470–1475, Appendix Y, Annual Report, 1879.

Congress, by act passed August 2, 1882, appropriated the sum of \$45,000 for continuing the improvement. This sum was applied to dredging, for which \$33,000 was allotted, and to repair and preservation of the piers bordering the canal.

Contract was entered into with Williams & Upham on the 19th of September, 1882, for the dredging, at 16 cents per cubic yard. Repairs to piers were made by day labor and purchase of material.

The work of dredging commenced in September, 1882, and closed in November, resuming in April following. The dredging was mostly done in the area lying opposite the Northern Pacific Railroad Docks and over several bars formed by the action of winter and spring storms and near the bay end of the canal. Total quantity dredged during the fiscal year, 114,492 cubic yards.

Upon application of the contractors and for sufficient reason the time for completing the contract has been extended to the 15th of November next. The work for the coming season will be mainly with a view to deepening the harbor area and channels from the canal to the docks.

From the experience of a number of years and from the history of this work it is believed that a large amount of dredging must be done annually to keep the area free from shoals which form at exposed points, and which are largely due to the effect of waves driving through the canal during storms and beating up the bottom of the dredged area, which is generally of a light and easily shifted material. The action of propeller wheels also disturbs the bottom more or less, in addition to which is the tendency of the material to "flatten out" along the sides and edges of "cuts." It has to be borne in mind that the harbor of Duluth is in reality an artificial one, the depth where the principal docks now are having averaged about 9 feet before the canal was excavated through Minnesota Point. The canal was commenced in 1870, and before the improvement of the harbor was undertaken by the United States. The piers bordering the canal were built without any apparent regard to the effect of future scour and deepening of the canal, and as the scour increases their stability will probably be endangered. The canal was badly located, and as a result of the separation of the harbors of Duluth and Superior, each with its own independent connection with the lake, two channels of entrance have to be watched and maintained by the Government. More harbor room is needed. In strong gales from the north and northeast vessels entering the harbor frequently find difficulty in keeping off the undredged area.

On the pier-work was expended 64,466 feet, B. M., of lumber, 83 cords of stone filling, and 3,900 pounds of iron. There was laid on the north pier 865 linear feet of decking, and on the south pier 305 linear feet, both measured from the outer end.

The piers are now in fair condition, but the east pier-head should be renewed.

Vessels drawing 14 feet of water can now reach any of the docks, and 16 feet draught can be carried at this writing through the canal. The general depth will be increased by the close of the season of 1883.

The Government does not own any of the land adjoining the canal piers. It would be advantageous to the United States to possess title to a small strip of land on each side of the canal from bay to lake, as space is required frequently for receiving and framing material, &c. The land could probably be secured at small outlay.

The necessity of dredging certain points in the harbor over again every year or two, and the advantage of being able to dredge to greater or less extent independently of contract work, lead to the conviction that it would be economical in the end were the Government to construct and operate a dredging machine of from 1,000 to 1,500 cubic yards capacity per day, together with the necessary steam-tug and scows. This plant could be utilized for both Duluth and Superior harbors.

Liberal appropriations are needed in order to keep the harbor in a condition commensurate with its commercial importance. For the fiscal year ending June 30, 1885, the sum of \$110,000 can be profitably expended in about the following proportions:

For dredging	\$90,000
Repairs to piers.....	20,000
	<hr/> 110,000

Looking forward to the necessity of dredging the shoals in the harbor, which will probably form again before the opening of navigation next spring, it would be of advantage could a part at least of the appropriation asked for be available during the coming winter in order that contract may be entered into before the following spring for the dredging just referred to.

Mr. Guy Wells, assistant engineer, has been in local charge of work for the improvement of the bay of Superior, including the harbor of Duluth, and is entitled to much credit for the faithful and economical manner in which he has discharged his duties.

Estimated cost of present project.....	\$212,988 36
Amount expended under present project to June 30, 1883, (including outstanding liabilities).....	\$79,070 67
Amount expended prior to present project (January 1881) ..	<u>270,651 81</u>

Total amount expended to June 30, 1883 (including outstanding liabilities) 349,722 48

This work is in the collection district of Duluth. Duluth, Minn., is the nearest port of entry. The collections at this port for the fiscal year ending June 30, 1883, were \$14,184.03.

Abstract of appropriations made for the harbor of Duluth, Minn.; how expended, and to be expended, &c.

Appropriations.	Construc- tion of breakwater, &c.	Repairs of piers, &c.	Dredging inside har- bor, &c.	Amounts appropri- ated.
By act approved March 3, 1871.....	\$80,000			\$80,000 00
By act approved June 10, 1872.....	50,000			50,000 00
Allotted from act approved March 3, 1873.....		\$32,723 59	\$3,325 61	36,049 20
By act approved June 23, 1874.....		1,879 54	8,120 48	10,000 00
By act approved March 3, 1875.....			35,000 00	35,000 00
By act approved August 14, 1876.....		6,000 00	9,000 00	15,000 00
By act approved June 18, 1878.....		865 96	23,134 04	30,000 00
By act approved March 3, 1879.....		4,000 00	20,400 00	25,000 00
By act approved June 14, 1880.....		5,000 00	20,000 00	25,000 00
By act approved March 3, 1881.....		5,000 00	35,000 00	40,000 00
By act passed August 2, 1882.....		4,145 91	18,527 87	45,000 00
Total	110,000	60,215 00	179,507 48	<u>371,049 20</u>

July 1, 1883, balance on hand for repairs of piers, dredging, &c., \$21,326.72.

Amounts expended prior to present project (January, 1881) viz:

Breakwater.....	\$110,000 00
Canal piers, &c	45,698 33
Dredging, &c.....	<u>114,953 48</u>
Total	270,651 81

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Total amount expended to June 30, 1883:

Breakwater.....	\$110,000 00
Canal piers, &c.....	60,215 00
Dredging, &c.....	179,507 48
Total	349,722 48

Total amount expended under present project (January, 1881) to June 30, 1883:

Canal piers, &c.....	\$14,517 54
Dredging, &c.....	64,553 13
Total	79,070 67

Estimate for carrying out present project (adopted in 1881)..... 212,988 36
 Remaining to be appropriated 127,988 36

Money statement.

July 1, 1882, amount available..... \$393 94
 Amount appropriated by act passed August 2, 1882..... 45,000 00

45,393 94

July 1, 1883, amount expended during fiscal year, exclusive of
 outstanding liabilities July 1, 1882..... \$18,468 11
 July 1, 1883, outstanding liabilities..... 5,599 11
 24,067 22

July 1, 1883, amount available..... 21,326 72

Amount (estimated) required for completion of existing project adopted
 in 1881 127,988 36

Amount that can be profitably expended in fiscal year ending
 June 30, 1885:
 For dredging \$90,000 00
 Repairs to and renewal of portions of piers..... 20,000 00
 110,000 00

Abstract of proposals opened September 14, 1882, by Capt. Charles J. Allen, Corps of Engineers, Saint Paul, Minn., for dredging in the inside harbor of Duluth, Minn.

No.	Names and addresses of bidders.	Names and addresses of sureties.	Dredging.
1*	Tully H. Smith, Milwaukee, Wis	D. G. Rogers and Uriel B. Smith, Milwaukee, Wis.	Per cu. yd. \$0 19
2	Carkin, Stickney & Cram, East Saginaw, Mich.	Isaac Bearinger and Farnham Lyon, East Saginaw, Mich.	0 19
3	Williams & Upham, Duluth, Minn	Chas. E. Boewick and Walter Van Brunt, Duluth, Minn.	0 16
4†	Chicago Dredging and Dock Company, Chicago, Ill.	C. S. Crane and Jacob W. Skinkle, Chicago, Ill.	0 22

* Informal. Tully H. Smith's signature on bidder's bond not witnessed.

† Informal, C. S. Crane, president of the company, going on as bondsman for the company; also informal, the bondsman not having justified before a United States official as required by law, and in bidder's bond paragraph reading "given under our hands and seals this — day of September, 1882," day of the month not given.

Contract awarded to Williams & Upham.

COMMERCIAL STATISTICS.

Arrivals and clearance of vessels, &c., 1882.

Description.	Vessels.	Screw steamers.	Paddle steamers.
ARRIVALS.			
American vessels from American ports	260	424	.....
American vessels from foreign ports	2	8	.....
Foreign vessels from foreign ports	18	95	26
Total 1882	280	527	26
Total 1881	243	352	71
Total 1880	202	298	29
Total 1879	175	296	31
Total 1878	59	309	38
Total 1877	41	245	43
CLEARANCES.			
American vessels for American ports	259	431	.....
American vessels for foreign ports	1	7	.....
Foreign vessels for foreign ports	17	91	26
Total 1882	277	529	26
Total 1881	245	343	72
Total 1880	201	294	29
Total 1879	173	293	31
Total 1878	58	301	34
Total 1877	40	245	43

Increase in arrivals of all kinds in 1882 over 1881 167
 Increase in clearances of all kinds in 1882 over 1881 173

NOTE.—The “in transit trade” of the port of Duluth for the fiscal year ending June 30, 1883, is as follows:

Value of merchandise \$2,999,240 00
 Estimated duties thereon 1,690,117 05

Statement of freights forwarded and received by railroads at Duluth for the year 1882.

Commodities.	By Saint Paul and Duluth Railroad.	By Northern Pacific Railroad.	Total.
FORWARDED.			
Salt	<i>Pounds.</i> 27,243,600	<i>Pounds.</i> 5,205,770	<i>Pounds.</i> 32,449,370
Iron	18,824,882	.....	18,824,882
Coal	157,985,020	249,379,857	407,364,877
Merchandise	73,098,178	69,118,179	142,216,357
Railroad material .....	.....	74,732,164	74,732,164
Lime and cement .....	.....	10,315,470	10,315,470
Lumber and shingles .....	.....	76,097,250	76,097,250
Total	277,151,680	484,848,690	762,000,370
RECEIVED.			
Flour	64,878,040	1,488,000	66,366,040
Grain	74,482,745	183,352,000	257,834,745
Merchandise, &c.	92,508,628	9,701,717	102,210,345
Total	231,871,408	134,541,717	426,413,125

COMPARISON WITH PREVIOUS YEARS.

Total received and forwarded:

Pounds.
 1882 1,188,413,495
 1881 859,660,838
 1880 769,680,497
 1879 602,538,667
 1878 354,974,561
 1877 311,208,341
 1876 277,197,587

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Receipts and shipments by lake during the year 1882 at the port of Duluth, Minn.

Commodities.	Freight received.	Freight shipped.	Total.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Merchandise	147, 650, 000	97, 525, 700	175, 175, 700
Salt	34, 500, 000		34, 500, 000
Railroad and pig iron	117, 115, 522		117, 115, 522
Lumber	18, 318, 000		18, 318, 000
Coal	510, 000, 000		510, 000, 000
Flour		64, 720, 000	64, 720, 000
Wheat and corn		230, 369, 140	230, 369, 140
Total, 1882	897, 584, 122	392, 634, 840	1, 150, 218, 962
Total, 1881	591, 183, 468	347, 687, 737	938, 871, 205
Total, 1880	266, 247, 108	368, 366, 251	634, 613, 359
Total, 1879	278, 946, 047	316, 917, 673	595, 863, 720
Total, 1878	154, 704, 305	189, 052, 477	333, 756, 782
Total, 1877	131, 297, 155	165, 753, 284	297, 150, 439
Total, 1876	77, 510, 436	192, 676, 050	270, 186, 486

The season of 1882 was the longest period of navigation at this port for many years, with the single exception of 1878. The lake was free from ice nearly all of last winter, and, with the exception of the obstruction from drift ice that began to pack at the head of the lake in March, there was no obstruction to navigation during any part of last winter or spring.

Opening and closing of the harbor at Duluth, Minn.

Year.	Opening.	Closing.	Year.	Opening.	Closing.
1855	April 15	December 16.	1869	April 25	November 12.
1856	April 16	November 22.	1870	April 12	November 21.
1857	May 27	November 20.	1871	April 5	December 6.
1858	March 20	November 20.	1872	March 9	November 24.
1859	May 25	November 8.	1873	May 10	December 30.
1860	April 7	December 4.	1874	May 2	December 11.
1861	June 12	December 12.	1875	May 12	December 10.
1862	April 28	December 16.	1876	May 2	December 19.
1863	May 10	December 7.	1877	April 26	December 17.
1864	April 23	December 1.	1878	March 28	January 2, 1879.
1865	April 22	December 8.	1879	April 17	December 12.
1866	May 6	December 10.	1880	May 1	December 17.
1867	April 19	December 1.	1881	May 8	November 24.
1868	April 1	November 21.	1882	April 15	December 30.

DD 2.

DREDGING SUPERIOR BAY, WISCONSIN.

The present plan as to dredging was adopted in 1881, and contemplated—

1. Deepening and enlarging the channel between the piers;
2. Dredging channel from the entry past the mouth of the Nemadji River around and parallel to the shore of Superior Bay, to Quebec Wharf;
3. Thence from Quebec Wharf along the west side of the bay to an intersection with the channel of the Saint Louis River opposite Conner's Point;
4. Up the Nemadji River for about half a mile;
5. The preservation, by deepening and enlarging, the old Quebec Wharf Channel. The dredging to provide for a depth of 16 feet at low water. The preservation of the piers for the present was placed at \$25,000.

Total estimated cost, \$312,080.

For the history of this work to the close of the fiscal year ending June 30, 1879, see pages 1470-1475, Appendix Y, Annual Report, 1879; also, see abstract of appropriations, how expended, &c., appended to this report.

Under the appropriation of \$40,000, by act of Congress passed August 2, 1882, for continuing operations, a contract was entered into September 19, 1882, with Williams & Upham, of Duluth, at 17 cents per cubic yard, for about \$30,000 worth of dredging. This contract has been extended, as to time, to November 15, next.

The dredging was principally done in enlarging and deepening the Quebec Wharf Channel; in cutting a channel from the latter to the Northern Pacific Railroad Dock, and in deepening the channel at the entry.

Quantity of material dredged and removed, 103,629 cubic yards.

Some work was also done in protecting the breach in Minnesota Point, known as "the Opening," from further scour by the action of wind and waves. For this purpose there was built an embankment 380 feet long by 12 feet in height, and 32 feet in width at top, crowning it with fascines and rock. This work was done by day labor and purchase of material. A sand-fence 750 feet in length was also put up. There were expended in this work—

Brush, cords	81
Stone, cords	72
Lumber, feet B. M	2,282
Cedar posts	96

The embankment was of sand, thrown up by scrapers.

With the funds remaining from appropriations it is proposed to continue work between the piers at the entry in the Quebec Channel and along the front of the Northern Pacific Railroad Dock; also to make some necessary repairs to the piers and to protect Minnesota Point, so far as the funds will admit of.

Vessels drawing 14 feet of water can now pass through the entry and up to the Northern Pacific Railroad Dock, and it is expected that 15 to 16 feet depth of channel will obtain through the entry and up to this dock by the close of the season. The exact condition of the United States dredging, June 30, is reported by Assistant Wells as follows:

There is now a good straight channel through the entry, 104 feet wide on bottom, over 125 feet wide at top, and 16 feet deep. The Quebec Channel is 250 feet wide, of which 150 feet in width has not less than 15 feet depth of water, and 100 feet with 12 to 13 feet of water. The Northern Pacific Dock Channel is from 75 to 100 feet wide, with 16 feet depth of water. Any vessel not drawing more than 14 feet can get to the Northern Pacific Dock, but the channel should be widened and angles rounded off.

In affording the depth immediately necessary to meet the demands of commerce a small appropriation does not admit of dredging the channels to the full width; this full width, with pertaining depth, must be made as appropriations permit the means. By reference to the map of Superior Bay, herewith, it will be seen that during high winds sailing vessels will need the aid of a steam-tug in rounding from the entry into the Quebec Channel.

The dredging has been distributed, so far as it could be, in accordance with the expressed wishes of the commercial interests most directly concerned in the improvement of the harbor.

The shoaling in the entry since 1874 has been gradual and is largely due to the effect of the canal at Duluth. As in the case of the harbor of Duluth, dredged areas will probably require frequent retouching.

The wharf-line of Superior City has not been finally decided upon by the authorities of Douglass County; the line under consideration is

upon the map just referred to, and appears unobjectionable so far as the United States works of improvement are concerned.

The advisability of some steps being taken by Congress to preserve Minnesota Point from erosion is referred to in the last Annual Report.

In pursuance of the present plan the sum of \$110,000 can be profitably expended during the fiscal year ending June 30, 1885, in about the following proportions, viz:

For dredging.....	\$85,000
For repairs to and renewal of portions of the piers	25,000
	<hr/> 110,000

A report by Assistant Engineer Guy Wells, giving the details of work for the season of 1882 in the Bay of Superior, is herewith.

Under date July 9, 1883, the collector of customs at Marquette, Mich., writes in regard to Superior City Harbor:

That inasmuch as no deputy collector is stationed at Superior City, no arrivals or departures of vessels were reported, and no revenues were collected, though Superior City is within the district of Superior.

Abstract of appropriations made for improving Superior Harbor, Wisconsin, how expended, and to be expended, &c.

Appropriations.	For repairs and beach protection, &c.	Expended and to be expended in construction and repairs of piers, &c.	Expended and to be expended in dredging &c.	Amounts appropriated.
By acts approved—				
March 3, 1867		\$63,000 00		\$63,000 00
April 10, 1869		45,000 00		45,000 00
July 7, 1870		40,000 00		40,000 00
March 3, 1871		60,000 00		60,000 00
June 10, 1872		50,000 00		50,000 00
Allotted from act approved March 3, 1873.		41,322 64	\$423,628 16	63,950 80
Allotted from appropriation "repairs of harbors on northern lakes."	\$45,433 00			\$45,433 00
By acts approved—				
August 14, 1876	\$3,000 00			\$3,000 00
June 18, 1878	\$3,000 00			\$3,000 00
March 3, 1879		5,000 00		5,000 00
June 14, 1880		5,000 00		5,000 00
March 3, 1881			\$10,000 00	\$10,000 00
By act passed—				
August 2, 1882	\$1,800 00	8,200 00	\$30,000 00	40,000 00
Totals	13,233 00	317,522 64	62,628 16	393,383 80

(a) Of these amounts there was expended during June and July, 1879, in dredging in the bay of Superior, on a line connecting the harbors of Duluth and Superior, the sum of \$2,000. These amounts were not included in the original estimate.

(b) Of this amount there was expended in dredging between the piers at the natural entry the sum of \$3,397.95, and in dredging from the entry channel to the wharves of Superior City, the sum of \$19,230.21.

(c) This amount was expended in dredging in the bay of Superior, between the piers at the entry, along a line leading from the entry into and up the Nemadji River, and in the Quebec Wharf Channel and vicinity; between the piers, about \$1,800; otherwise about \$8,200.

(d) This amount was expended in the fall of 1882 in protecting the breach in Minnesota Point, known as "the Opening."

(e) This amount is being expended in dredging between the piers at the entry and in the Quebec and Northern Pacific Wharf channels and vicinity.

Amount expended under appropriations prior to adoption of the present plan (January, 1881)	\$335,513 26
Amount expended to June 30, 1883 (including outstanding liabilities), under original and present plan	370,057 80
Amount expended under present plan to June 30, 1883 (including outstanding liabilities)	34,474 54
Estimated cost of present project	312,080 00
Remaining to be appropriated	262,080 00

Money statement.

July 1, 1882, amount available.....	\$4,461 58
Amount appropriated by act passed August 2, 1882.....	40,000 00
	<hr/> 44,461 58
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$14,999 81
July 1, 1883, outstanding liabilities.....	6,135 77
	<hr/> 21,135 58
July 1, 1883, amount available.....	23,326 00
	<hr/> 262,080 00
Amount (estimated) required for completion of existing project	<hr/>
Amount that can be profitably expended in fiscal year ending June 30, 1885:	
For dredging.....	\$85,000 00
Repairs to and renewal of portions of piers	25,000 00
	<hr/> 110,000 00

Abstract of proposals opened September 14, 1882, by Capt. Charles J. Allen, Corps of Engineers, Saint Paul, Minn., for dredging in the bay of Superior, Wisconsin.

No.	Names and addresses of bidders.	Names and addresses of sureties.	Dredging. <i>Per cu. yd.</i>
*1	Chicago Dredging and Dock Company, Chicago, Ill.	C. S. Crane and Jacob W. Skinkle, Chi- cago, Ill.	\$0 24
†2	Tully H. Smith, Milwaukee, Wis	D. G. Rogers and Uriah B. Smith, Mil- waukee, Wis.	25
3	Carkin, Stickney, & Cram, East Saginaw, Mich.	Isaac Bearinger and Farnham Lyon, East Saginaw, Mich.	25
4	Williams & Upham, Duluth, Minn.....	Charles E. Bostwick and Walter Van Brunt, Duluth, Minn.	17

* Informal; C. S. Crane, president of the company, going as bondsman for the company. Also informal, the bondsmen not having justified before a United States official as required by law, and in bidders' bond paragraph reading, "Given under our hands and seals, this — day of September, 1882"; day of the month not given.

† Informal. Tully H. Smith's signature on bidder's bond not witnessed.

Contract awarded to Williams & Upham.

REPORT OF MR. GUY WELLS, ASSISTANT ENGINEER, OF WORK DONE AT DULUTH AND SUPERIOR HARBORS.

SAINT PAUL, MINN., *December 12, 1882.*

SIR: I have the honor of submitting the following report of work done at Duluth Harbor, Minnesota, and at Superior Bay, Wisconsin, during the summer of 1882:

During the winter of 1881-'82 there were three severe wind-storms from the northeast, which broke up the ice in the canal and inner harbor at Duluth, and drove in the floating ice from the lake until the whole inner harbor was gorged with ice to its bottom. The effect of this was to scrape up the sand and gravel in the bottom of the bay and shove it along with the ice, thereby forming shoals at several points in the dredged area of the harbor.

When the first barges and vessels came in, in the spring, they invariably grounded on these shoals. It therefore became an imperative necessity that the shoals be removed at once. Accordingly an agreement was made with Williams & Upham to dredge them out for 20 cents per cubic yard, the material to be measured in the scows. The dredging was commenced on the 27th day of April, and continued uninterruptedly until the 26th day of May, at which time they had taken out 15,000 cubic yards, amounting to the sum of \$3,000, which sum was all the money available for that purpose. The money thus expended did not entirely remove all the shoal places to a depth of 16 feet, yet the shoalest parts were so far removed that vessels entering the harbor had no further trouble by getting aground during the remainder of the season.

The appropriation for this work having been entirely expended, no further work was done until after the new appropriation was made, in the month of August.

1622 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

On the 25th day of August an advertisement was issued to contractors, inviting proposals for dredging, which proposals were opened on the 14th day of September, at which time the work was awarded to Williams & Upham, of Duluth, Minn., who on the 19th day of September entered into contract to do the dredging in the harbor of Duluth. They commenced the work immediately after the execution of the contract, and continued it until the 28th day of November, during which time they had taken out 60,222 cubic yards of material, amounting, at 16 cents per cubic yard, to \$9,635.52. This dredging, with the exception of taking out two small shoals in the inner harbor, was all done in enlarging the west end (on the southerly side) of the dredged area of the harbor, and also in widening the north end, or entrance to the Blast Furnace Channel, to a width of 250 feet, so as to enable vessels to go into the south slip of the new coal dock, recently built (in front of elevators B and C) by the "Ohio Central Coal and Barge Company."

* * * * *

DULUTH CANAL PIERS.

The work done on these piers during the summer of 1882 consisted in decking the north pier with 3-inch plank, 865 feet in length by 18 feet in width, and the south pier 305 feet in length by 18 feet in width; also, the facing of the west end of the south pier with 6-inch white-oak plank, substantially secured to the pier with drift and screw bolts; also, in replacing 83.6 cords of stone in the bulkhead of the south pier.

In consequence of the deepening of canal by scouring, the west end of the north pier was partially undermined, and had commenced inclining towards the canal. It was drawn back and firmly secured in its place by a large iron rod, one end of which was firmly secured to the double row of piling on the back side of the pier, and extending it through the pier; the other end of the rod was securely fastened on the front side or face of the pier.

* * * * *

The canal piers are now generally in a very good condition, except one section or crib of 50 feet in length, of the south pier, which settled about 20 inches in the center of the section and bulged out towards the canal about the same distance during a recent storm.

To fully understand this settling or undermining of these piers, it is proper to state that when the canal was cut* it was only excavated 14 feet deep, and the cribs were only sunk 14 feet below the surface of the water. Since that time, owing to severe storms and the strong current at times through the canal, the bed has scoured out, so that the water now in the canal is from 18 to 35 feet in depth. The bed of the canal being so much lower than the bottom timbers of the piers, the latter have a tendency to slide into the canal during any severe storm. The bulkhead at the outer end of the south pier is in a rickety condition, the trouble being that it was not sunk deep enough when built. During every storm the waves get under it, raising it up and down, thus letting the stone filling out at the bottom. All that holds it in place are two or three timbers on each side, which extend into and are fastened to the pier. It has been in about this condition for two or three years, and it may stay in place several years longer.

SUPERIOR BAY, WISCONSIN.

Williams & Upham, under their contract, dated September 19, 1882, commenced the work of dredging in this harbor on the 2d day of October, and continued the work until the 16th day of November, during which time they had taken out 47,580 cubic yards of material, amounting, at 17 cents per cubic yard, to \$8,088.60.

This dredging was all done in digging a channel from the Quebec Dock Channel to and in front of the "Northern Pacific Railroad Dock."

* * * * *

OPENING.

This is a narrow place in Minnesota Point, which is the natural breakwater between the lake and the bay.

The point is composed of very fine, loose sand, without any vegetation. During the heavy wind-storms that there prevail from the northeast, this sand blows away

* This work was done by the city of Duluth, and was commenced in September, 1870. The first boat passed through in August, 1871, but the dredging was not entirely completed until August, 1872.

and drifts like snow, often digging out holes to the depth of from 12 to 15 feet, and down to within a few feet of the surface of the water in the lake. There was expended this season in strengthening this point the sum of \$1,711. The work consisted in scraping back the sand, making an embankment 380 feet long, 12 feet high, 32 feet wide on top, with side slopes of $1\frac{1}{2}$ on 1. The top of this embankment was covered with fascines of brush, and on top of the brush was placed a layer of stone about 1 foot in thickness, thus covering the whole length and width of the top of the embankment.

There was also built, as an experiment, 750 linear feet of post and board fence, to prevent the sand from drifting and blowing away, with a view of preventing a breach where none has as yet occurred, but where one was likely to occur at any time, as the one just repaired.

NATURAL ENTRY.

Owing to the lateness of the season when the appropriation was made, it was not considered advisable to do any work at this point this season, but it is intended to commence dredging between the piers as soon as navigation opens in the spring and the weather will permit, and also to do some work on the South or Wisconsin Pier.

GENERAL REMARKS.

The great and rapid improvements being made around the head of Lake Superior, and the greatly increased commerce of the lakes, render it impossible to furnish facilities fast enough to meet the increased and increasing business. Large appropriations are necessary from year to year to improve and enlarge the harbors of Duluth and Superior City. To improve the Nemadji River up as far as the Northern Pacific Railroad Bridge, and since so many mills have been erected on the west side of Rice's Point and up along the shores of Saint Louis Bay, an appropriation is needed to dig a channel along the west side and parallel to Rice's Point, and one from the deep water in the channel of the Saint Louis River, between Rice's Point, Minnesota, and Conner's Point, Wisconsin, up along the established dock line on the south side of Saint Louis Bay, to a point in deep water near the south end of Grassy Point. Between Grassy Point and Fond du Lac the river is narrow and in most places the water is deep. After a channel is dug across the Flats of Saint Louis Bay, the upper portion of the river can be improved at a comparatively small cost.

Respectfully submitted.

GUY WELLS,
Assistant Engineer.

Maj. CHARLES J. ALLEN.

COMMERCIAL STATISTICS, 1882.

SUPERIOR, Wis., March 16, 1883.

DEAR SIR: Your favor is received.

The estimated value in general terms and round numbers of the trade and commerce of Superior for 1882 was as follows:

Fish, salt and fresh	\$15, 000
Furs, hides, and wool	10, 000
Hay, wheat, oats, potatoes, &c.	25, 000
Butter, eggs, small fruits, maple sugar	10, 000
Cattle, sheep, and horses	20, 000
Merchandise of all kinds	400, 000
Mill and agricultural machinery	150, 000
Lumbermen's outfits and supplies	200, 000
Lumber, lath, shingles	150, 000
Timber, saw-logs, ties, poles, wood	450, 000
Railroad builders' outfits and supplies	150, 000
Brick, lime, and coal	20, 000
Total	1, 600, 000

During the greater part of the season of 1882 the Lake Michigan line of steamers made regular trips to Superior, and some of the Lake Erie steamers called. The town built a substantial extension to its principal pier, 175 feet in length, and dredged

a channel 16 feet deep and about 50 feet wide at the end and on both sides of the pier, so that lake steamers come to the pier without difficulty. The Northern Pacific Railroad Company finished in October last its pier, 166 feet wide and 1,000 feet long. This is said to be one of the finest piers on the entire chain of lakes. It is built of heavy timbers, with sand and clay filling, has three sunken tracks in the center, and cost over \$100,000. It is said the company will build a large warehouse upon it, and handle iron, coal, lumber, salt, and merchandise over it this year.

For 1883 the probabilities are there will be a large increase in trade over former years. Two railroads, the Northern Pacific and the Chicago, Saint Paul, Minneapolis and Omaha, now terminate on the bay of Superior, and they will no doubt deliver to and receive from steamers here a large amount of freight. The failure of an appropriation by Congress for improvement of the harbor this year is greatly to be deplored, as the prospective demands of commerce require considerable dredging in the channels and to the docks. It is hoped, however, that the amount on hand from last year will be sufficient to deepen and straighten the channel from the entry to the docks, so that steamers drawing 16 feet may easily enter and depart.

Very respectfully,

JAMES BARDOU.

Maj. CHAS. J. ALLEN,
United States Engineers.

D D 3.

IMPROVEMENT OF HARBOR AT GRAND MARAIS, MINNESOTA.

The original project for the improvement of this harbor as a harbor of refuge, adopted in 1879, provides for a breakwater and dredging within the area bounded by Mayhew's Point and inner shore line, to afford anchorage ground for vessels of 16 feet draught.

At the close of last fiscal year the breakwater, 280 feet long, lacked three courses of completion.

Under the appropriation of \$20,000 made by act passed August 2, 1882, a contract was entered into September 26, 1882, with Coll. P. Macdougall, as the lowest bidder, for the completion of the breakwater, the breakwater to be 330 feet in length, and 8 feet in height above low water of the lake.

A contract was also entered into September 19, 1882, with Williams & Upham, of Duluth, as lowest bidders, for further dredging in the harbor; both contracts to be completed September 1, 1883.

Under the former contract a pier-head 50 feet long, 40 feet wide, and 26 to 30 feet high, with superstructure, will be built at the sea end of the breakwater, and the superstructure of the present work will be carried up three courses, filled with stone, and decked.

On account of the exposed position of Grand Marais Harbor, and the lateness of the season when the contracts were let, nothing was done last fall excepting to secure the work, as left by the former contractor, from injury by winter storms.

Work on the breakwater was resumed in June, and by the close of the fiscal year considerable progress had been made in the construction of the bulkhead crib for lake end of breakwater, and in making a strong connection with the shore.

Before this work was undertaken by the United States Government there was no harbor of refuge on the north shore of Lake Superior between Duluth and the British Possessions. Although American steamers take the southerly shore of Lake Superior, American sailing vessels

and American steam tugs, which run along the north shore, and Canadian steamers which carry American passengers, require harbors of refuge on that shore. Vessels drawing 15 to 16 feet of water can now make the harbor of Grand Marais and ride out storms from any direction.

The sum of \$25,000 can be profitably expended during the fiscal year ending June 30, 1885, in enlarging and deepening the harbor area and in care of and repairs to piers. As the latter are liable to damage from storms there should always be some funds available for their maintenance.

Estimated cost of original project..... \$139,669 40
Amount expended to June 30, 1883 (including outstanding liabilities) ... 40,188 71

This work is in the collection district of Duluth. Duluth, Minn., is the nearest port of entry; at which place the revenue collected during the fiscal year ending June 30, 1883, amounted to \$14,184.03.

**ABSTRACT OF APPROPRIATIONS MADE FOR IMPROVING HARBOR AT GRAND MARAIS
COOK COUNTY, MINNESOTA.**

By act approved March 3, 1879	\$10,000
By act approved June 14, 1880	10,000
By act approved March 3, 1881	20,000
By act passed August 2, 1882	20,000
Total	60,000

Money statement.

July 1, 1882, amount available	\$3,577 61
Amount appropriated by act passed August 2, 1882.....	20,000 00
	<hr/>
	23,577 61
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$849 08
July 1, 1883, outstanding liabilities	2,917 24
	<hr/>
	3,766 32
July 1, 1883, amount available.....	19,811 29
	<hr/>
Amount (estimated) required for completion of existing project.....	79,669 40
Amount that can be profitably expended in fiscal year ending June 30, 1885.	25,000 00

Abstract of proposals opened September 14, 1882, by Capt. Charles J. Allen, Corps of Engineers, Saint Paul, Minn., for dredging in the harbor of Grand Marais, Minn., on the north shore of Lake Superior, about 106 miles northeast of Duluth, Minn.

No.	Names and address of bidders.	Names and residence of sureties.	Dredging.
1	Williams & Upham, Duluth, Minn.*	Charles E. Bostwick and Walter Van Brunt, Duluth, Minn.	Per cu. yd. 30 cents.

* Contract awarded.

1626 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of proposals opened September 14, 1882, by Capt. Charles J. Allen, Corps of Engineers, Saint Paul, Minn., for constructing breakwater in the harbor of Grand Marais, Cook County, Minnesota, on the north shore of Lake Superior, about 106 miles northeast of Duluth, Minn.

No.	Names and addresses of bidders.	Names and addresses of sureties.	Square timber in place, 16,723 cubic feet.		Plank and joists in place, 52,248 feet, B. M.		Stone in place, 2,118 cubic yards.	
			Per cubic foot.	Total.	Per thousand.	Total.	Per cubic yard.	Total.
1	Coll. P. Macdougall, Duluth, Minn.	Charles H. Graves and Luther Mendenhall, of Duluth, Minn.	\$0 34	\$5,685 82	\$20	\$1,044 96	\$1 40	\$2,965 20
*2	Wilson, LeMay & Son, Duluth, Minn.	Chancey Joslin and Howard C. Kendall, Duluth, Minn.	0 85	5,853 05	18	940 46	1 55	3,282 90

No.	Names and addresses of bidders.	Names and addresses of sureties.	Drift bolts in place, 53,792 pounds.		Spikes in place, 2,580 pounds.		Screw bolts, nuts, and washers in place, 1,500 pounds.		Aggregate.
			Per pound.	Total.	Per pound.	Total.	Per pound.	Total.	
1	Coll. P. Macdougall, Duluth, Minn.	Charles H. Graves and Luther Mendenhall, of Duluth, Minn.	\$0 05	\$2,689 60	\$0 06	\$154 80	\$0 07	\$105 00	\$12,645 38
2	Wilson, LeMay & Son, Duluth, Minn.	Chancey Joslin and Howard C. Kendall, Duluth, Minn.	06	3,237 52	05	129 00	06	90 00	13,532 90

* Informal. Signatures of sureties on bidders' bond not witnessed.

Contract awarded to Coll. P. Macdougall.

COMMERCIAL STATISTICS.

Exhibit of business done in the year 1882, at Grand Marais, Cook County, Minnesota.

Name and description of vessels.	Home port.	Tonnage.	Times arrived at Grand Marais.
Tug Siskowit	Duluth	37.	50
Tug T. H. Camp	do	34.	31
Tug Amethyst	do	27.	4
Tug Pacific	Detroit	42.	23
Tug Rambler	Tonawanda	50.	2
Tug N. Bootin	Bayfield	51.	4
Steam yacht Frank C. Fero	Houghton	32.62	1
Schooner Jane Anderson	Escanaba	16.15	5
Steam barge A. A. Morrison	Duluth	108.	2
Schooner Maple Leaf	Marquette	130.	1
Propeller Sovereign	Port Sarnia	500.	1
Barge Kasota	Bayfield	100.	1

Freight received:		
100 tons general merchandise		\$13,299 01
Freight shipped:		
1,529 packages salt fish		6,310 00
70 tons fresh fish		4,196 37
Furs		1,886 32

During winter 1881-'82 the harbor was not closed by ice.

The proposed Grand Marais and Vermillion Railroad is projected from Grand Marais directly north to a point near the boundary line, thence west to Vermillion Lake, with a branch running east to connect with a proposed road running southwest from Prince Arthur's Landing, Canada. It is intended as a mineral road, with facilities for general traffic.

The Duluth and Iron Range Railroad is now being built from "Two Harbors" (formerly known as Agate and Burlington bays, 25 miles northeast from Duluth) to the iron mines, 72 miles. The company expects to have the road in operation by August 1, 1884, and to ship the same year 100,000 tons of ore, and in 1885 400,000 tons. Large ore and merchandise docks are now in course of construction at "Two Harbors," which will be the shipping point for ore going to the lower lakes. This harbor is the only one between Grand Marais and Duluth, but is as yet only a shipping point, and not a harbor of refuge.

Casualties on the north shore of Lake Superior, 1872 to 1880.

Name of vessel.	Where loss occurred.	Date of loss.	Class of vessel.	Tonnage.	No. of lives lost.	Loss to vessel.	Loss to cargo.	Character of loss.
Yon Tell.....	Grace Harbor.....	Sept. 27, 1872	Scow.....	150	.....	\$2,500	\$600	Total wreck.
Lottie Barnard.	Agate Bay.....	—, 1876	Steamer.....	90	2	6,000	500	Sunk.
Charlie.....	Grand Marais.....	—, 1877	Schooner.....	75	.....	2,000	200	Went ashore.
Cumberland.....	Rock of Ages.....	Aug. —, 1878	Propeller.....	1,000	.....	100,000	1,000	Total wreck.
Stranger.....	Off Grand Marais.	Nov. —, 1875	Schooner.....	15	4	800	800	Sunk.
Siskowit.....	Near Little Marais.	Nov. —, 1879	Tug.....	87	.....	2,000	500	Went ashore.
Amethyst.....	do.....	do.....	do.....	18	1	1,000	.....	Do.
Quebec.....	Off Grand Marais.	Oct. 17, 1880	Propeller.....	1,300	.....	.....	6,000	Washed overboard.
Siskowit.....	do.....	Nov. —, 1880	Tug.....	37	.....	200	.....	Broken wheel.
Siskowit.....	Lester River.....	June 23, 1882	do.....	87	.....	400	.....	Ran on the beach and upset.

NOTE.—It is said that the masters of the Canada steamers have had orders to familiarize themselves with Grand Marais Harbor, Minn.

APPENDIX E E.

HARBORS ON LAKE SUPERIOR (EAST OF SUPERIOR CITY), ON GREEN BAY, AND ON THE WESTERN SHORE OF LAKE MICHIGAN, NORTH OF MILWAUKEE, WISCONSIN.

REPORT OF CAPTAIN F. A. HINMAN, CORPS OF ENGINEERS, OFFICER IN TEMPORARY CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|--|--|
| 1. Ontonagon Harbor, Michigan. | 10. Green Bay Harbor, Wisconsin. |
| 2. Eagle Harbor, Michigan. | 11. Harbor of refuge at entrance of Sturgeon Bay Canal, Wisconsin. |
| 3. Marquette Harbor, Michigan. | 12. Ahnepee Harbor, Wisconsin. |
| 4. Harbor of refuge at Grand Marais, Michigan. | 13. Kewaunee Harbor, Wisconsin. |
| 5. Manistique Harbor, Michigan. | 14. Two Rivers Harbor, Wisconsin. |
| 6. Harbor at mouth of Cedar River, Michigan. | 15. Manitowoc Harbor, Wisconsin. |
| 7. Menomonee Harbor, Michigan and Wisconsin. | 16. Sheboygan Harbor, Wisconsin. |
| 8. Oconto Harbor, Wisconsin. | 17. Port Washington Harbor, Wisconsin. |
| 9. Pensaukee Harbor, Wisconsin. | 18. Deposits of sand in Portage Lake, Michigan. |

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., July 26, 1883.

GENERAL: I have the honor to transmit herewith the annual reports for the works in my temporary charge for the fiscal year ending June 30, 1883.

Lieut. Col. H. M. Robert, Corps of Engineers, was in charge of these works to May 31, 1883, on which date he was relieved of them by Maj. J. W. Barlow, Corps of Engineers. I relieved Major Barlow of them the 22d ultimo.

The reports were prepared by Mr. L. Y. Schermerhorn, assistant engineer, principally under the direction of Lieutenant-Colonel Robert. Mr. Schermerhorn was in immediate charge of all the works throughout the year and for some years past. He left on the 4th instant to report to Lieutenant-Colonel Robert for duty.

My work on the reports has been to bring them to the close of the fiscal year. As I have not yet had an opportunity to inspect all the works, the recommendations for future work are those of Lieutenant-Colonel Robert.

Very respectfully, yours,

F. A. HINMAN,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

E E 1.

IMPROVEMENT OF ONTONAGON HARBOR, MICHIGAN.

Original estimate (see Report of the Chief of Engineers, 1867, page 20)..... \$363, 770
 Appropriated..... 257, 600

This improvement consists in the construction of two parallel piers about 250 feet apart, extending from the mouth of Ontonagon River to the 18-foot curve in Lake Superior, with dredging between the piers so as to afford a channel of entrance not less than 12 feet deep at low water, connecting the deep water in the lake with the deep water in the river.

Expenditures have resulted in the construction of 750 linear feet of pile pier and revetment, 3,540 linear feet of crib pier, the dredging of 10,546 cubic yards of material from the outer bar, and the removal of the remains of an old crib from the channel between the piers. Of the foregoing 3,540 linear feet of crib pier, 650 linear feet in the west pier requires two courses of superstructure, and 200 linear feet in the east pier one course of superstructure to complete the portion of the pier work already in course of construction. A channel about 150 feet wide exists between the piers, carrying over 12 feet depth at low water. The formation of a bar in the vicinity of the outer entrance to the piers reduces the available depth to something usually less than 11 feet. The dredging which has been done at this harbor was applied toward deepening the channel through the outer bar; the work was of but temporary relief. Rapid pier extension to the deep water of the lake seems to be the only permanent method of overcoming the difficulty, and therefore no appropriation should be especially made for dredging at this harbor, since the funds on hand will always permit the small amount of dredging which may be necessary.

During the past fiscal year operations have been confined to pier extension, as follows:

Under a contract with Joel Rich, dated June 1, 1881, one crib was placed in extension of the east and partial superstructure built over six cribs in the west pier, thereby completing this contract August 5, 1882. Under a contract with the same party, dated September 16, 1882, for the building and placing of six cribs and building partial superstructure over 400 linear feet of pier extension, one crib was placed in extension of the east pier and nearly all of the superstructure built over 400 linear feet of pier extension.

During the present season operations will consist in the completion of this contract, under which there yet remains to be placed five cribs in extension of east pier and one course of superstructure over 200 linear feet of pier extension.

Continuation of the pier extension is the work contemplated during the fiscal year ending June 30, 1885.

It is highly probable that in the near future the pile pier or revetment near the inner end of the west pier will require to be provided with a sand-tight lining similar to that applied to the pile pier at Ahnapee and Sturgeon Bay harbors; the present condition of the revetment is such as to permit large quantities of sand to pass into the channel between the piers, and this sand, carried by the current outward, probably hastens the formation of the outer bar.

Money statement.

July 1, 1882, amount available.....	\$565 76
Amount appropriated by act passed August 2, 1882.....	20,000 00
	20,565 76
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$3,592 90
July 1, 1883, outstanding liabilities	1,040 70
	4,633 60
July 1, 1883, amount available.....	15,932 16
Amount (estimated) required for completion of existing project.....	106,170 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	60,000 00

Abstract of proposals for furnishing labor and material for building and placing six crib sub-structures and eight partial superstructures at Ontonagon Harbor, Michigan, opened Sep-tember 5, 1882, by Maj. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bid- ders.	Pine timber 12 by 18 and 12 by 12 inches, framed, 13,000 linear feet.	Hemlock timber 12 by 18 and 12 by 12 inches, framed, 12,000 linear feet.	Pine plank 3-inch, 6,000 feet, B. M.	Drift bolts 1-inch round, 23,000 pounds.	Screw bolts, 1½-inch, round, 3,300 pounds.	Spikes, wrought, 7 inches long, 200 pounds.	Stone, 900 cords.	Total approximate value of bid.
1	Coll. P. Macdougall, Duluth, Minn.	Per lin. ft. \$0 30	Per lin. ft. \$0 30	Per M. \$18	Pr. lb. \$0 07	Pr. lb. \$0 08	Per lb. \$0 07	Pr. cord. \$9 50	\$18,226
2	Joel Rich, Ontonagon, Mich.	30	30	12	4½	6	4½	9 00	17,094

Contract awarded to Joel Rich, dated September 16, 1882; in progress.

List of materials and labor used at Ontonagon Harbor, Michigan, in construction of eight crib substructures, each 50 by 20 by 12½ feet, and nine partial superstructures, under con-tract dated June 1, 1881, with Joel Rich.

Articles.	Quantities.		Price.	Amount.
	Nine partial superstructures.	Eight crib substructures.		
Pine timber, 12 by 18 and 12 by 12 inches, lin. ft. .	7,455	26,924	\$0 20	\$6,875 80
Pine plank M feet, B. M. .	6,952	17,876	12 00	297 98
Drift bolts.....pounds..	6,154	21,855	3½	910 29
Screw bolts.....do..	297	5,264	5	278 05
Spikes.....do..	175	725	4	86 00
Stone.....cords..	296.4	812.51	7 95	8,807 88
Total cost.....	\$4,144 70	\$13,061 25	.....	17,206 95

Cost of each crib substructure	\$1,682 66
Cost of substructure, per linear foot.....	32 65
Cost of superstructure, per linear foot	9 21

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COMMERCIAL STATISTICS.

Name of harbor, Ontonagon, Mich.
Collection district, Superior, Mich.
Nearest light-house, Ontonagon, Mich.

Arrival and departure of vessels during the year ending December 31, 1882.

Description.	Arrivals.			Departures.		
	No.	Tonnage.	Crews.	No.	Tonnage.	Crews.
Steamers	171	106, 190	3, 950	171	106, 190	3, 950
Sailing vessels.....	17	5, 600	130	17	5, 600	130
Total	188	111, 790	4, 080	188	111, 790	4, 080

EXPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Copper	tons..	651	Merchandise, general.....	tons..	214
Fish	do..	9	Shingles	number..	19, 000, 000
Hides	do..	7	* Do	do..	1, 000, 000
Lumber	feet B. M..	7, 000, 000	Slabs	cords..	1, 200
* Do	do..	300, 000			

IMPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Apples	barrels..	585	Merchandise, general.....	tons..	1, 772
Cattle	head..	143	Oats	bushels..	27, 850
Coal	tons..	700	Powder.....	tons..	58
Corn	bushels..	4, 800	Pork-barrels.....	number..	715
Flour	barrels..	4, 400	Salt	barrels..	280
Hogs	head..	113	Sheep.....	head..	82
Horses	number..	62	Stone	cords..	600
Lumber	feet, B. M..	63, 000	Sugar.....	barrels..	420
Lime.....	barrels..	950	Whisky	do..	113

The above information was obtained from Mr. James Mercer.

E E 2.

IMPROVEMENT OF EAGLE HARBOR, MICHIGAN.

Constructive operations at this harbor were completed in the spring of 1879, and the original project carried as far as the present demands of commerce seemed to warrant. (See Report of the Chief of Engineers, 1878, page 1133.) The improved entrance is 130 feet wide, 14 feet deep, and defined by guiding cribs placed on each side of the channel.

During the past fiscal year operations were confined to replacing 6½ cords of stone in the guiding cribs. During the present season some minor repairs may be required. The available funds are held for application to such repairs as may become necessary for the preservation of the work.

Money statement.

July 1, 1882, amount available.....	\$3, 867 53
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	65 00
July 1, 1883, amount available.....	3, 802 53

* Transported by railroad.

COMMERCIAL STATISTICS.

Name of harbor, Eagle Harbor, Mich.
Collection district, Superior, Mich.
Nearest light-house, Eagle Harbor, Mich.

Arrival and departure of vessels during the year ending December 31, 1882.

Description.	Arrivals.		Departures.	
	No.	Tonnage.	No.	Tonnage.
Steamers	112	90,600	112	90,600
Sailing vessels	8	4,800	8	4,800
Total	120	95,400	120	95,400

EXPORTS BY WATER FOR THE YEAR ENDING DECEMBER 31, 1882.

Beer	cases..	60	Live stock	number..	6
Butter	pounds..	3,950	Lumber	feet, B. M.	1,500
Copper	tons..	1,935	Machinery	pounds..	1,250
Corn	bushels..	86	Merchandise, general	do.	74,400
Fish	packages..	600	Oats	bushels..	1,648
Flour	barrels..	13	Oil	barrels..	6
Fuse	pounds..	8,900	Potatoes	bushels..	95
Hardware	do.	3,000	Rags	pounds..	7,315
Hides	number..	660	Tallow	do.	7,119
Household goods	pounds..	11,820	Whisky	barrels..	12
Iron, old	do.	119,511			

IMPORTS BY WATER FOR THE YEAR ENDING DECEMBER 31, 1882.

Apples	barrels..	849	Leather	pounds..	231,719
Beef	do.	12	Lime	barrels..	495
Beer	do.	58	Liquor	pounds..	18,690
Do	cases..	240	Live stock	number..	271
Brick	number..	38,000	Lumber	feet, B. M.	221,000
Castings	tons..	85	Machinery	pounds..	177,292
Cement	barrels..	439	Malt	do.	8,210
Coal	tons..	3,048	Merchandise, general	do.	341,347
Corn	bushels..	4,603	Oats	bushels..	37,511
Dry goods	tons..	46	Oil	barrels..	294
Feed	do.	294	Plaster, land	do.	86
Flour	barrels..	3,519	Pork-barrels	number..	146
Fruit	pounds..	11,975	Provisions	pounds..	440,671
Groceries	do.	545,749	Salt	barrels..	329
Hardware	tons..	83	Shingles	number..	79,000
Hay	do.	388	Whisky	barrels..	48
Iron and steel	pounds..	231,719			

The above information was obtained from Mr. William P. Raley.

E E 3.

IMPROVEMENT OF MARQUETTE HARBOR, MICHIGAN.

Original estimate (see Report of Chief of Engineers, 1867, page 67)..... \$385,129 58
Amount appropriated to date..... 314,230 00

The improvement consists in a breakwater covering the docks and wharves of the city, and was completed to its present length of 2,010 linear feet in 1875. Since this date operations have been confined to such work of repairs as was necessary for the preservation of the work.

During the past fiscal year the work of a comprehensive plan of repair, commenced in 1881, was continued, resulting in the repair of 1,050

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linear feet of the breakwater, thereby placing in connection with the work previously done 1,600 linear feet in thorough repair. Besides the work of removing decayed and replacing it with sound timber, and refilling the work with stone, and replanking the docks, about 180 cords of rip-rap were placed along the lake side of the work, and seventeen snubbing posts were placed at intervals of about 100 feet apart along the harbor side of the breakwater. Owing to the impossibility of specifying the work to be done, these repairs were carried on by hired labor and purchase of material in open market.

During the present season the completion of the work of repairs is contemplated. The balance of funds will be held to meet the contingency of repair rendered liable at any time from the exposed position of the work.

As stated in previous annual reports, the breakwater should be eventually extended 400 linear feet, at an estimated cost of about \$68,000.

Money statement.

July 1, 1882, amount available	\$697 46
Amount appropriated by act passed August 2, 1882.....	16,000 00
	<hr/> 16,697 46
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	6,574 32
	<hr/> 10,123 14
July 1, 1883, amount available	10,123 14
Amount (estimated) required for completion of existing project.....	68,000 00

List of the materials and labor used at Marquette Harbor, Michigan, in repair of 1,050 feet of the breakwater, during the season of 1882, by hired labor and purchase of materials in open market.

Articles.	Quantities.	Price.	Amount.
Pine timber.....M feet B. M..	42,492	\$11.007	\$467 71
Pine and Norway plank.....do...	120,527	11.1835	1,347 91
Stone.....cords...	491.47	6.00	2,948 83
Drift bolts.....pounds...	4,213	4	168 52
Spikes.....do...	4,150	4½	186 75
Tools, &c.....do...			12 43
Labor.....			756 86
Superintendence.....			514 75
Total.....			6,408 80

COMMERCIAL STATISTICS.

Name of harbor, Marquette, Mich.
Collection district, Superior, Mich.
Nearest light-house, Marquette, Mich.

Arrival and departure of vessels during the year ending December 31, 1882.

Description.	Arrivals.		Departures.	
	No.	Tonnage.	No.	Tonnage.
Steamers and sailing vessels	1 148	779,599	1,162	784,231

EXPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Fish*.....	packages..	7,800	Iron, pig*.....	tons..	9,640
Iron ore*.....	tons..	942,956	Lumber*.....	feet, B. M..	3,550,350
Do.....	do..	108,516	Slabs*.....	cords..	2,400

IMPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Apples*.....	barrels..	2,500	Iron and steel*.....	pounds..	898,968
Brick*.....	number..	218,960	Merchandise, general.....	do..	92,176,512
Coal*.....	tons..	95,000	Plaster, land*.....	tons..	590
Feed*.....	do..	80	Provisions*.....	pounds..	75,000
Flour*.....	barrels..	425	Shingles.....	number..	17,000,000
Fruit*.....	pounds..	89,881	Stone*.....	cords..	200
Hay*.....	tons..	180			

The above information was obtained from Marquette, Houghton and Ontonagon Railroad Company and F. B. Spear & Co.

E E 4.

HARBOR OF REFUGE AT GRAND MARAIS, MICHIGAN.

Original estimate (see Report of Chief of Engineers, 1881, page 2053).....	\$450,000
Appropriated	70,000

This improvement is to consist of two parallel piers 500 feet apart, extending to the 22-foot curve in Lake Superior, and connected with the Bay of Grand Marais, by a cut through the sand-spit which separates the bay from the lake.

The first appropriation was \$10,000, made under the act of June 14, 1880; the subsequent appropriations were \$20,000 under act of March 3, 1881, and \$40,000 under act of August 2, 1882.

Under date of October 9, 1882, a contract was entered into with Charles S. Barker for the construction and placing of twenty-six cribs, and the excavation of about 25,000 cubic yards of material; this contract was the initial work of improvement. During the winter of 1883 the contractor began the construction of the cribs required under his contract, at Marquette, Mich., intending to tow them after the opening of navigation to Grand Marais.

During the fiscal year twenty-six cribs have been built at Marquette to a height of from six to ten courses; of this number six cribs have been towed to Grand Marais, and five of them sunk in extension of the west pier.

The dredging necessary for the foundation of the cribs and for opening the cut between the bay and lake to facilitate the work was commenced May 25, and at the close of the fiscal year 19,029 cubic yards of material had been removed.

The construction of a house for the use of the inspector was completed.

During the present season it is proposed to complete the work required under the contract with Charles S. Barker.

During the fiscal year ending June 30, 1885, further extension of the piers and dredging are contemplated.

By a deed of gift from Wellington R. Burt, dated May 14, 1883, title was conveyed to the United States to that part of the sand spit through which the cut will be made connecting the Bay of Grand Marais with Lake Superior, and by a concurrent resolution of the legislature of the State of Michigan, dated June 1, 1883, authority was given to the United States to acquire title to the same.

A part of the sand spit would be cut off from the mainland by the above-named cut, and an agreement was made with Philo M. Everett,

* Transported by water.

the owner, whereby the United States, without compensation to the said Everett, was permitted to so cut off from the mainland this part of the sand spit.

These papers were duly recorded in the register's office of Schoolcraft County, Michigan, and the original papers transmitted to the Chief of Engineers.

As there is at present but little local commerce to be benefited by this improvement, and since its earliest value as a harbor of refuge to the commerce of Lake Superior will not be reached before \$300,000 have been applied to the improvement, and, also, since the isolated position of the work renders the expenditure of small appropriations uneconomical, it would seem desirable that the work should be pushed forward to early completion by aid of liberal appropriation. The county seat of Schoolcraft County will probably be located at this point, and the opening of the country adjacent to Grand Marais will at an early date develop large shipments of valuable timber from this point.

Money statement.

July 1, 1882, amount available	\$27,837 86
Miscellaneous receipts	84 00
Amount appropriated by act passed August 2, 1882	40,000 00
	67,921 86
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$8,253 63
July 1, 1883, outstanding liabilities.....	1,939 98
	10,193 61
July 1, 1883, amount available.....	57,728 25
Amount (estimated) required for completion of existing project.....	380,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	200,000 00

Abstract of proposals for furnishing labor and materials for building and sinking twenty-six crib substructures and dredging 25,000 cubic yards of material at harbor of refuge at Grand Marais, Mich., opened September 23, 1882, by Maj. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Pine timber 12 by 18 and 12 by 12 inches, framed; 32,000 linear feet.	Hemlock timber 12 by 18 and 12 by 12 inches, framed; 50,000 linear feet.	Pine plank, 3-inch; 73,000 feet B. M.	Iron drift bolts, 1-inch, round; 68,000 pounds.	Iron screw bolts, 1 1/2 inches, round; 23,000 pounds.	Wrought-iron spikes 7 inches long; 8,000 pounds.	Stone; 2,100 cords.	Dredging; 25,000 cubic yards.	Total approximate value of bid.
		Pr. lin. ft.	Pr. lin. ft.	Pr. M.	Pr. lb.	Pr. lb.	Pr. lb.	Pr. cord.	Pr. cu. yd.	
1	Coll. P. Macdougall, Duluth, Minn.	\$0 37	\$0 37	\$20	\$0 07	\$0 07	\$0 07	\$12 00	\$0 50	\$78 08
2	Green's Dredging Company, Chicago, Ill.	36	35	20	05	06	05	12 00	30	68 10
3	Knapp & Gillen, Racine, Wis.	32	32	25	04 1/2	06 1/2	06	10 50	34	62 13
4	Green Bay Dredge and Pile-driver Company, Green Bay, Wis.	33	33	20	05	06	05 1/2	10 00	30	61 95
5	John H. Gillette, Marquette, Mich.	29	29	16	04 1/2	05	04	10 00	30	57 08
6	Carkin, Stiekney & Cram, East Saginaw, Mich.	31 1/2	30	20	04	05 1/2	07	9 50	22	58 15
7	Charles S. Barker, Sault Sainte Marie, Mich.	32	32	18	04 1/2	05 1/2	05	8 00	25	55 67

Contract awarded to Charles S. Barker, dated October 9, 1882; in progress.

E E 5.

IMPROVEMENT OF MANISTIQUE HARBOR, MICHIGAN.

The improvement at this harbor was the formation of a dredged channel 150 feet wide and 12 feet deep between the slab-pier previously built by local enterprise, and almost entirely for the use and benefit of the Chicago Lumbering Company.

By the acts of June 14, 1880, and March 3, 1881, \$6,000 was appropriated, being the estimated cost of the above-described dredging. In the season of 1880, under a contract with the Chicago Lumbering Company, 11,780 cubic yards were removed by dredging. In October, 1880, a part of the west slab-pier was carried away by a storm, and the survey of the harbor made at that time developed the fact that the line of the pier was directly across the natural channel. The contract with the Chicago Lumbering Company expired by limitation on December 1, 1880, but it was extended to November 30, 1881, upon the condition that the company in repairing the piers should change the direction of the same so as to permit the use of the natural channel. Subsequently the company declined to make the change, and the officer in charge recommended that the contract for further dredging be discontinued, as being by its own terms and conditions inoperative, and he further stated that it did "not appear advisable to expend any more money at this point until the parties interested in the improvement recognize more fully the right of the United States to prevent the building of piers across the natural channel." (See Report of the Chief of Engineers, 1881, pages 2055 to 2058; 1882, page 2118.)

Further work by the United States was then "suspended by reason of the refusal of the company controlling the harbor to rectify the pier lines when rebuilding the same." (Report of the Chief of Engineers, 1882, page 268.) [House Mis. Doc. No. 15, Forty-seventh Congress, second session.]

Money statement.

July 1, 1882, amount available	\$3,583 11
July 1, 1883, amount available	3,583 11

E E 6.

IMPROVEMENT OF MOUTH AND HARBOR OF CEDAR RIVER, MICHIGAN.

Original estimate (see Report of the Chief of Engineers 1882, page 2121)....	\$138,000
Appropriated	15,000

This improvement consists in the construction of two parallel piers 200 feet apart, extending from the mouth of Cedar River to the 16-foot curve in Green Bay, with dredging between the piers so as to afford a channel of entrance not less than 12 feet deep at low water, connecting the deep water in Green Bay with the deep water in the river.

The survey of the mouth of Cedar River made in September, 1881, developed the existence of an outside shoal about 600 feet beyond the point that would probably be the heads of the piers. In the survey of 1881, no borings were made on this shoal on account of lack of funds. In the report on Cedar River under date of November 3, 1881, the officer in charge said:

The exact direction that should be given to the outer portion of the piers can only be determined after a careful examination of the shoal. * * * This question can be decided during the progress of the work.

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Under date of September 1, 1882, instructions were received from the Chief of Engineers to suspend action towards the expenditure of the appropriation of \$15,000, made August 2, 1882, until after an examination and report on this shoal had been made. In September, 1882, a special examination was made of the shoal, the results of which are set forth in the appended reports under date of January 10, 1883. This examination did not in any way modify the plans and estimates as set forth in report dated November 20, 1881 (Report of the Chief of Engineers, 1882, page 2120).

Under date of April 16, 1883, a contract was entered into with Green's Dredging Company for the construction of 450 linear feet of pile-pier. This contract was the initial work of improvement.

During the fiscal year work was commenced under the above contract, but no part of the work was accepted or completed.

During the present season the operations contemplated are the completion of the above-named contract, under which there yet remains to build 550 linear feet pile-pier, the contract having been increased 100 feet.

Continuation of the pier extension is the work contemplated during the fiscal year ending June 30, 1885.

Money statement.

Amount appropriated by act passed August 2, 1882.....	\$15,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	580 62

July 1, 1883, amount available.....	14,419 38
-------------------------------------	-----------

Amount (estimated) required for completion of existing project	123,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885..	40,000 00

Abstract of proposals for furnishing labor and materials for building 450 linear feet of pile-pier at Cedar River Harbor, Michigan, opened April 3, 1883, by Lieut. Col. Henry M. Robert, Corps of Engineers.

Materials and labor.	Quantities.	Names of bidders.			
		W. T. Casgrain, Milwaukee, Wis.	Green Bay Dredge and Pile-Drive Company, Green Bay, Wis.	Truman & Cooper, Manitowoc, Wis.	Green's Dredging Company, (Chf. sago, Ill.
Round piles, furnished and driven..... linear feet..	15,000	\$0 30	\$0 25	\$0 20	\$0 25
White-oak timber, framed and put in place.. feet B. M..	27,500	50 00	50 00	55 00	50 00
Norway pine sheet-piling, furnished and driven.. do.....	55,000	35 00	36 00	30 00	32 00
Wrought-iron screw-bolts and tie-rods..... pounds.....	11,000	08	06	05 1/2	5
Pine timber 12 by 12 inches, furnished and put in place..... linear feet.....	900	40	30	25	30
Pine timber 6 by 12 inches, furnished and put in place..... linear feet.....	900	20	20	20	25
Stone furnished and put in place..... cords.....	500	7 00	6 00	6 00	5 50
Pine plank, laid..... feet B. M..	4,500	20 00	20 00	18 00	20 00
Wrought iron spikes..... pounds.....	450	08	06	05	08
Total approximate value of bid		12,846 00	11,332 00	10,276 00	9,974 00

Contract awarded to Green's Dredging Company, dated April 16, 1883; in progress.

REPORT OF MAJOR HENRY M. ROBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., January 10, 1883.

SIR: The survey of the vicinity of the mouth of Cedar River, Michigan, made in September, 1881, showed that a shoal existed in front of the mouth of the river that should be more carefully examined before making the final location of piers for improving the entrance.

I had this shoal more carefully examined last September, and I inclose the report of Assistant Engineer L. Y. Schermerhorn, and a map of the entire survey, upon which have been entered the results of this later examination.

Nothing has been developed to modify in any way my report of November 30, 1881, as published on pages 2120-2124 of Annual Report of Chief of Engineers for 1882.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. L. Y. SCHERMERHORN, ASSISTANT ENGINEER.

MILWAUKEE, WIS., *January 10, 1883.*

SIR: I have the honor to submit the following report of the examination of the shoal lying off the mouth of Cedar River, Michigan, developed by the survey of September, 1881, and described in your report on Cedar River, Michigan, to the Chief of Engineers, under date of November 30, 1881 (Report of Chief of Engineers, 1882, pages 2120-2124).

The examination of the shoal was made from September 24 to 29, 1882, and was confined to additional soundings, sufficient in number and position to exactly locate the extent of the shoal, together with borings to determine the character of the material of which it was composed. The extent of the shoal, as determined by the survey of September, 1882, does not differ materially from that obtained from the examination of September, 1881. Its extent is as follows:

Area circumscribed by 15-foot curve, 110,000 square feet.

Area circumscribed by 12-foot curve, 16,000 square feet.

The shoalest part has a depth of from 10.5 to 11 feet. The area of that part of the shoal circumscribed by the 15-foot curve and lying directly in front of the entrance to the piers, as laid down on the map of the examination of September, 1881, is 42,000 square feet.

The borings were made by sinking a three-quarter-inch wrought-iron pipe, by the aid of the water-jet, to as great a depth as possible. Where the character of the bottom was such as to prevent the penetration of the water-jet, attempts were made to drive a steel-pointed bar into the bottom, but in all cases where the water-jet failed in penetration it was found impossible to force the steel point into the bottom, the obstacles being in all cases a deposit of bowlders, which covers the surface of the northern half of the shoal, and which resisted all efforts towards penetration.

Nineteen borings were made on the shoal; of this number four were carried to a depth of from 20 to 22 feet below datum, at which depth clay and stones occurred; five borings to a depth of from 17 to 18 feet, clay and stones again occurring; with the remaining ten borings practically no penetration into the lake bed was obtained, the bottom being thickly covered with closely packed bowlders, which were plainly visible through the water. Upon the southerly part of the shoal, or that portion lying in front of the proposed entrance to the piers, the borings were all carried to a depth of from 17 to 22 feet below datum. The shoal seems to consist of a deposit of sand, bowlders, and gravel, superposed on clay. The southerly part of the shoal which extends across the line of entrance to the proposed piers should be removed by dredging, so as to give an available depth of 15 feet at low water, and the borings here indicate that this can be easily accomplished. This recent examination shows that the direction of the piers, as proposed on the map accompanying your previous report, under date of November 30, 1881, was well chosen, and no change would seem to be required.

Very respectfully, your obedient servant,

L. Y. SCHERMERHORN,
Assistant Engineer.

Maj. HENRY M. ROBERT,
Corps of Engineers, U. S. A.

1640 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

COMMERCIAL STATISTICS.

Name of harbor, Cedar River, Michigan.
Collection district, Superior, Mich.
Nearest light-house, Menomonee, Mich.

Arrival and departure of vessels during the year ending December 31, 1882.

Description.	Arrivals.			Departures.		
	No.	Tonnage.	Crews.	No.	Tonnage.	Crews.
Steamers.....	490	57,000	3,470	490	57,000	3,470
Sailing vessels.....	220	74,600	1,520	220	74,600	1,520
Total.....	710	131,600	4,990	710	131,600	4,990

EXPORTS BY WATER FOR THE YEAR ENDING DECEMBER 31, 1882.

Fish.....packages..	10,000	Posts.....number..	320,000
Laths.....number..	7,000,000	Telegraph poles.....do..	25,000
Lumber.....feet, B. M.	48,230,000	Ties, railroad.....do..	280,000
Pickets.....number..	1,000,000		

IMPORTS BY WATER FOR THE YEAR ENDING DECEMBER 31, 1882.

Apples.....barrels..	200	Hardware.....tons..	200
Beer.....do...	500	Hay.....do...	500
Brick.....number..	100,000	Iron and steel.....pounds..	2,000,000
Coal.....tons..	100	Live stock.....number..	500
Corn.....bushels..	7,000	Oil.....barrels..	150
Dry goods.....tons..	50	Pork-barrels.....number..	800
Feed.....do...	130	Salt.....pounds..	700,000
Flour.....barrels..	750	Stone.....cords..	500
Groceries.....pounds..	96,000	Oats.....bushels..	35,000

The above information was obtained from Mr. Jesse Spalding.

E E 7.

IMPROVEMENT OF MENOMONEE HARBOR, MICHIGAN AND WISCONSIN.

Original estimate (see Report of the Chief of Engineers, 1874, I, page 139)...	\$212,000
Appropriated.....	190,000

This improvement consists in the construction of two parallel piers, about 400 feet apart, extending from the mouth of the Menomonee River to the 16-foot curve in Green Bay, with dredging between the piers so as to afford a channel of entrance not less than 14 feet deep at low water, connecting the deep water in Green Bay with the deep water in the river.

Expenditures have resulted in the construction of 585 linear feet of slab-pier, 2,777 linear feet of pile-pier, 1,200 linear feet of crib-pier, and the dredging of 205,828 cubic yards of material from the channel between the piers. Of the foregoing 1,200 linear feet of crib-pier, 200 linear feet in the south pier require about three courses, and 300 linear feet about five courses, while 300 linear feet of the north pier require two courses of superstructure to complete the portion of the pier work already in process of construction.

The work done has resulted in the formation of a channel 200 feet wide, carrying a depth of 12 feet, and including a channel 100 feet wide, carrying about 14 feet at low water. During the past fiscal year 3,950 cubic yards of material were removed from the channel between the piers under an agreement with S. M. Stephenson, esq., at the rate of 10 cents per cubic yard. Under date of September 16, 1882, a contract

was made with Messrs. Truman & Cooper for the building and placing of four crib substructures in extension of the south pier, one crib substructure in extension of the north pier, and the building of partial superstructure over 300 linear feet of the south pier. At the close of the fiscal year this work had not yet been commenced.

During the present season the completion of the work to be done under this contract will be accomplished, together with the replacing of the displaced crib at the present end of the north pier. This latter work is to be done under an agreement with Messrs. Truman & Cooper, whereby they are to restore the crib to its original status at a total cost to the United States of \$800.

Continuation of pier extension is the work contemplated during the fiscal year ending June 30, 1885.

As described in the last Annual Report, the rapid shoaling of the bay in the vicinity of the entrance to the piers has rendered necessary the construction of a greater length of pier extension than originally estimated, and at an early date an increased estimate will be required for the necessary additional extension of the piers.

The commercial requirements of Menomonee Harbor demand a channel with sufficient depth to admit the passage at all times of deep-draught lumber vessels. At present they load to a draught of from 13 to 14 feet, and provision should be made for the formation and maintenance of a channel which will permit them at all times to load to their full capacity.

Money statement.

July 1, 1882, amount available.....	\$1 86
Amount appropriated by act passed August 2, 1882.....	15,000 00
	15,001 86
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	603 35
July 1, 1883, amount available.....	14,398 51
Amount (estimated) required for completion of existing project.....	22,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	22,000 00

Abstract of proposals for furnishing labor and materials for building and placing five crib substructures and six partial superstructures at Menomonee Harbor, Michigan and Wisconsin, opened September 5, 1882, by Maj. Henry M. Robert, Corp of Engineers.

No.	Names and addresses of bidders.	Pine timber 12 by 18 and 12 by 12 inches, framed, 11,000 linear feet.	Hemlock timber 12 by 18 and 12 by 12 inches, framed, 11,100 linear feet.	Pine plank, 3 inches, 7,000, feet, B. M.	Drift-bolts, 1 inch round, 20,000 pounds.	Screw-bolts, 1½ inches round, 3,400 pounds.	Spikes, wrought, 7 inches long, 400 pounds.	Stone, 750 cords.	Total approximate value of bid.
		Per lin. ft.	Per lin. ft.	Pr M.	Pr. lb.	Pr. lb.	Per. lb.	Pr. cord.	
1	Knapp & Gillen, Racine, Wis.	\$0 35	\$0 32	\$25	\$0 04½	\$0 06½	\$0 06	\$5 50	\$12,797 00
2	Green Bay Dredge and Pile- Driver Company Green Bay, Wis.	34	29	20	04½	06½	06½	5 50	12,371 00
3	Truman & Cooper, Manito- woc, Wis.	30	26	15	04	05	04	5 25	11,214 50

Contract awarded to Truman & Cooper, dated September 16, 1883; in progress.

1642 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

COMMERCIAL STATISTICS.

Name of harbor, Menomonee, Mich.
Collection district, Superior, Mich.
Nearest light-house, Menomonee, Mich.

Arrival and departure of vessels during the year ending December 31, 1882.

Description.	Arrivals.			Departures.		
	No.	Tonnage.	Crews.	No.	Tonnage.	Crews.
Steamers.....	265	106,577	6,053	266	106,988	6,062
Sailing vessels.....	523	153,000	3,477	524	153,899	3,891
Total.....	788	159,577	9,530	790	260,887	9,973

EXPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Bark.....	cords..	1,000	Lumber*.....	feet, B. M. .	45,000,000
Beer.....	barrels..	500	Machinery*.....	pounds..	100,000
Castings*.....	pounds..	200,000	Posts*.....	number..	1,000,000
Fish*.....	packages..	20,000	Rags*.....	pounds..	10,000
Furniture*.....	pieces..	2,000	Shingles*.....	number..	25,000,000
Hides*.....	number..	500	Slabs*.....	cords..	18,000
Household goods.....	pounds..	20,000	Stone.....	do.....	400
Iron, pig.....	tons..	2,000	Telegraph poles*.....	number..	1,000,000
Laths.....	number..	20,000,000	Ties, railroad*.....	do.....	1,000,000
Live stock.....	do.....	400	Wool*.....	pounds..	1,000

IMPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Apples*.....	barrels..	2,000	Leather.....	tons..	20
Beef*.....	pounds..	40,000	Lime*.....	barrels..	5,000
Beer.....	barrels..	1,000	Live stock.....	number..	400
Brick*.....	number..	250,000	Machinery.....	pounds..	20,000
Coal*.....	tons..	2,000	Malt.....	do.....	50,000
Corn*.....	bushels..	5,000	Merchandise, general.....	do.....	400,000
Dry goods.....	tons..	250	Oil.....	barrels..	1,000
Feed.....	do.....	3,000	Plaster, land.....	tons..	400
Flour.....	barrels..	5,000	Pork-barrels.....	number..	5,000
Fruit.....	pounds..	10,000	Provisions.....	pounds..	25,000
Groceries.....	do.....	250,000	Salt.....	do.....	12,000
Hardware.....	tons..	500	Stone.....	cords..	500
Hay.....	do.....	1,000	Wood.....	do.....	2,000
Iron and steel*.....	pounds..	250,000			

The above information was obtained from Joseph H. Somerville, deputy collector of customs.

E E 8.

IMPROVEMENT OF OCONTO HARBOR, WISCONSIN.

Estimate cost (see Report of the Chief of Engineers, 1883, page 2128).....	\$150,000
Appropriated.....	25,000

This improvement consists in the construction of two parallel piers, 150 feet apart, extending from the outer end of slab-pier built by the city of Oconto to the 10-foot curve in Green Bay, with the formation of a dredged channel between the piers, 100 feet wide, having a low-water depth of 10 feet at the outer end, gradually reducing to 8 feet at the shore-line; also the formation of a dredged channel in the river, 100 feet wide at bottom, with slopes of $1\frac{1}{2}$ to 1 foot, and 8 feet deep at low water, extending from the inner ends of the slab-pier to Section Street Bridge, in the city of Oconto, a distance of about 2 miles.

* Transported by water.

The work done during the past fiscal year was the initiative of the Government work at this harbor, and expenditures have resulted in the construction of 300 linear feet of slab-pier.

During the past fiscal year operations consisted in a survey of Oconto River between the mouth and city of Oconto, and also of Green Bay in the vicinity of the mouth, and the construction of the slab-pier, under a contract with the Green Bay Dredge and Pile-Driver Company, dated September 16, 1882, for 3,000 linear feet, more or less, of slab-pier. Under this contract work was commenced October 18, 1882, and at the close of the fiscal year 300 linear feet of slab-pier had been built.

From the appropriation for this harbor of August 2, 1882, \$6,000 was set apart to be used, in connection with the appropriation for other harbors, toward building a dredge, two dump scows, and the purchase of a tug. This work was completed during the fiscal year; for the details relating thereto see report for this fiscal year on Port Washington Harbor.

A survey of Oconto River from Green Bay to the city of Oconto was made in January, 1883, and the map and report thereof transmitted to the Chief of Engineers under date of March 31, 1883.

This report is appended hereto.

During the present season operations will consist in the completion of the existing contract for the extension of the slab-piers, under which there yet remains to be built 2,700 linear feet. The slab-piers built by the city of Oconto several years ago have been partially destroyed; this work the city of Oconto is at present engaged in replacing.

Continuation of pier extension with dredging is the work contemplated during the fiscal year ending June 30, 1885.

Money statement.

July 1, 1882, amount available	\$10,000 00
Amount appropriated by act passed August 2, 1882	15,000 00
	<hr/> 25,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$7,541 10
July 1, 1883, outstanding liabilities	832 11
	<hr/> 8,373 21
July 1, 1883, amount available	16,626 79
	<hr/>
Amount (estimated) required for completion of existing project	125,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	50,000 00

Abstract of proposals for furnishing labor and materials for the construction of 3,000 linear feet slab pier at Oconto Harbor, Wisconsin, opened September 5, 1882, by Maj. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Piles, furnished and driven, 25,200 linear feet.	Poles, furnished and placed, 600.	Iron wire No. 7, furnished and placed, 600 pounds.	Slabs and edgings, furnished and placed, 6,000 cords.	Total approximate value of bid.
		<i>Per linear ft.</i>	<i>Per pole.</i>	<i>Per pound.</i>	<i>Per cord.</i>	
1	Green's Dredging Company, Chicago	\$0 21	\$0 60	\$0 10	\$3 60	\$27,312
2	Green Bay Dredge and Pile-Driver Company, Green Bay, Wis.	15	85	08	1 96	16,218

Contract awarded to Green Bay Dredge and Pile-Driver Company, dated September 16, 1882; in progress.

1644 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

COMMERCIAL STATISTICS.

Name of harbor, Oconto, Wis.
Collection district, Milwaukee, Wis.
Nearest light-house, Sturgeon Bay, Wisconsin.

Arrival and departure of vessels during the year ending December 31, 1882.

Description.	Arrivals.			Departures.		
	No.	Tonnage.	Crews.	No.	Tonnage.	Crews.
Steamers.....	260	3, 600	175	260	3, 600	175
Sailing vessels.....	113	9, 300	248	113	9, 300	248
Total	373	12, 900	423	373	12, 900	423

EXPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Beer.....barrels..	1, 100	Machinery*.....pounds..	300, 000
Castings*.....pounds..	140, 000	Merchandise, general...do...	225, 000
Fish.....packages..	3, 500	Do*.....do.....	75, 000
Do*.....do.....	3, 500	Posts.....number..	2, 200, 000
Flour.....barrels..	3, 750	Potatoes.....bushels..	5, 000
Do*.....do.....	3, 750	Rags.....pounds..	120, 000
Hides.....number..	2, 000	Shingles.....number..	18, 000, 000
Laths.....do.....	6, 650, 000	Slabs*.....cords..	500
Do*.....do.....	6, 650, 000	Tallow.....pounds..	12, 000
Lumber and logs..feet, B. M..	32, 750, 000	Telegraph poles...number..	9, 000
Do*.....do.....	32, 750, 000	Ties, railroad.....do...	325, 000
Machinery.....pounds..	300, 000	Wool.....pounds..	27, 000

IMPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Apples.....barrels..	2, 900	Iron and steel.....pounds..	1, 300, 000
Barley.....bushels..	4, 600	Leather.....tons..	10
Beef.....pounds..	480, 000	Lime*.....barrels..	600
Beer.....barrels..	5, 000	Do.....do.....	600
Brick*.....M..	700	Live stock.....number..	550
Coal*.....tons..	380	Machinery.....pounds..	850, 000
Do.....do.....	380	Malt.....do.....	150, 000
Corn*.....bushels..	25, 000	Merchandise, general*...do...	2, 500, 000
Do.....do.....	25, 000	Merchandise, general...do...	7, 500, 000
Dry goods.....tons..	1, 240	Do.....barrels..	1, 200
Feed.....do.....	1, 200	Plaster, land.....tons..	50
Flour.....barrels..	9, 800	Pork-barrels*.....number..	777
Fruit.....pounds..	10, 000	Do.....do.....	2, 323
Groceries*.....do...	750, 000	Provisions*.....pounds..	45, 000
Do.....do.....	2, 250, 000	Do.....do.....	135, 000
Hardware*.....tons..	65	Salt*.....pounds..	300, 000
Do.....do.....	195	Salt.....do.....	300, 000
Hay.....do.....	200	Stone*.....cords..	100
Iron and steel*.....pounds..	1, 300, 000	Wheat.....bushels..	40, 000

The above information was obtained from W. H. Young, mayor.

REPORT OF LIEUTENANT-COLONEL HENRY M. ROBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., March 31, 1883.

SIR: By the river and harbor act of March 3, 1881, \$10,000 was appropriated for the improvement of Oconto Harbor, Wisconsin. As this appropriation was made upon the estimate of the city authorities of

* Transported by water.

Oconto for completing a project of their own at an expense of \$37,475.20 (in addition to \$6,262.56 which they had already expended) by which they were to obtain a channel 100 feet wide, and 10 feet deep from the city of Oconto, out to deep water in Green Bay, a distance, according to their estimate, of 12,360 feet, and as I did not see how their plan could be carried out to any such cost, and the city authorities declined to do the work even at much greater price than they stated the work to have cost them, upon your recommendation the Secretary of War ordered that no work be done until further legislative action. By the act of August 2, 1882, Congress appropriated \$15,000 additional for this work, and consequently a project was submitted and approved under which a contract was let last September for building 3,000 feet of slab pier.

In my report of May 30, 1881 (see Chief of Engineers' Report for 1881, page 2066), criticising the citizens' plan for Oconto Harbor, I said:

To carry out the original idea of obtaining a 10-foot channel would cost so much more than the estimate upon which this appropriation was based that it seems useless to consider the question. If the object of the improvement is to enable vessels to load with lumber at Oconto, a 12-foot channel would be required at least, as the vessels engaged in this trade draw, when loaded, from 12 to 14 feet. As Congress has never made any appropriation for such an improvement, although estimates have been at least twice submitted therefor, it is not necessary to consider the work as designed to aid lumber vessels in entering the river.

The only other object would be to provide a channel for tugs, scows, and rafts. Ten feet water would be desirable for such purpose, but 8 feet at low water, with 10 feet at the entrance, would probably satisfy immediate needs, and would be of great service.

I then, in accordance with what seemed to be the design of the appropriation, made an estimate of the cost of the cheapest and smallest improvement that would be of any practical value to Oconto Harbor, using slab piers as far as there was any hope of their standing. The estimate for the work outside the shore line was \$65,000 (about five times as great as the estimate of the city authorities for a deeper channel), and for the work inside the shore line, I roughly estimated for an 8-foot channel \$60,000, or over double the amount estimated by the city authorities for a 10-foot channel. These estimates were based upon the best data I could obtain without making a new survey, for which there was no need unless Congress decided to undertake the work of improvement after learning how inaccurate had been the data upon which the first appropriation was based.

As Congress, after having its attention called to the subject, made an additional appropriation of \$15,000 last August, I immediately had a new survey made to enable the improvement to be located more intelligently. No material change has occurred outside the shore line since the latest previous survey, and I would not at present modify the estimate of \$65,000 for the cost of the work outside the shore-line. This is, of course, upon the supposition that the United States will not have to rebuild the slab-pier, 1,000 feet long, built by the city of Oconto in the season of 1880, and of which the Government work is to be a continuation. The mayor has said that the city will rebuild these piers.

When the survey was made last September, it was found so difficult to survey the river, that this part of the work was deferred until winter. In January the river was surveyed on the ice by Assistant Engineer L. Y. Schermerhorn, whose report, together with a map of the survey, is appended hereto. The survey shows that to carry out the plan estimated for in my report of May 30, 1881 (Chief of Engineers' Report, 1881, page 2066), which provides for an 8-foot channel 100 feet wide from

Section Street Bridge, Oconto, out to the shore line, will require 360,000 cubic yards of dredging instead of 350,000 cubic yards, as previously estimated. Though I provided for nearly 100,000 cubic yards more dredging for an 8-foot channel than the citizens of Oconto estimated for a 10-foot channel, yet this survey shows that another 100,000 cubic yards must be added.

In the citizens' plan provision was made for a slab and pile protection of 2,400 feet of the shore at Lindsey's Bar. Whether this will be necessary, as well as any other shore protection, can be better determined during the progress of the improvement. To provide for such contingencies, as well as for superintendence, &c., I allowed 20 per cent. of the estimated cost of dredging. I do not think it necessary to increase this, though, of course, this would not provide for any extensive shore protection.

The revised estimate of the cost of the improvement is as follows:

For an 8-foot channel 100 feet wide, from Section Street Bridge, Oconto, to shore line of Green Bay:

360,000 cubic yards of dredging at 20 cents	\$72,000
Protection of banks, contingencies, &c	13,000
Total	85,000

For an 8-foot channel 100 feet wide, protected by piers, extending to the 10-foot curve in Green Bay:

4,000 linear feet of slab pier at \$5	\$20,000
500 linear feet of crib pier at \$40	20,000
75,000 cubic yards of dredging at 25 cents	18,750
Contingencies, superintendence, &c	6,250

Total	65,000
Cost of entire improvement for an 8-foot channel 100 feet wide	150,000

The line of the improvement is the same as originally proposed in the plan of the citizens of Oconto, upon which the first appropriation was based; that is, it follows the natural channel of the river, from Section Street Bridge, in Oconto, to the point where begins their cut-off, near the mouth, excepting that there is a cut-off through Spie's Slough instead of following the long bend of the main channel. No provision is made in the estimate for any expense in obtaining right of way on the lines of the cut-offs, as it is assumed that the city authorities will see that these are furnished gratis, as soon as the location of the improvement is approved.

When the work is completed it would seem reasonable to expect that it would require 5 per cent. of the original cost to keep the work in repair, as only a very small portion of the work is of a permanent nature. If the appropriations should be very small, or less than 10 per cent. of total cost, these items of annual deposit of material in the channel and deterioration of slab-pier would increase the cost above the estimated amount, which is \$150,000. I forward herewith Assistant Engineer L. Y. Schermerhorn's report and a map of the survey.

Very respectfully, your obedient servant,

HENEY M. ROBERT,
Lieutenant-Colonel of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. L. Y. SCHERMERHORN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., March 1, 1883.

SIR: I have the honor of submitting the following report on Oconto Harbor, Wisconsin:

This harbor is situated on the west shore of Green Bay, 27 miles north of Green Bay Harbor, and 22 miles south of Menomonee Harbor.

The survey of Green Bay in the immediate vicinity of the mouth of the Oconto River was made in September, 1882, and of that part of the river between its mouth and Section Street Bridge in the city of Oconto, a distance of about 3 miles, in January, 1883. This latter part of the survey was made from the ice, since the swampy character of the country rendered it inaccessible at any other season.

PHYSICAL CHARACTERISTICS.

The Oconto River has its source about 80 miles from its mouth, and drains about 1,000 square miles of water shed; its average discharge is about 800 cubic feet per second. The part of the river between the mouth and the city of Oconto has a width of from 150 to 250 feet, and a low-water channel depth of from 4 to 6 feet. The distance between the mouth of the river and the city of Oconto in a direct line is about 2 miles, while by the river this distance is increased to about 3 miles, in which it traverses a belt of low swampy ground, the elevation of which is but slightly above the surface of the river.

The bed of the river consists of sand and mud superposed on clay; for about 3,000 feet below Section Street Bridge the depth of the sand and mud is from 3 to 7 feet; for the remaining part of the river the clay occurs at a depth of over 8 feet.

Five miles north of the mouth of the river Peshtigo Point extends into Green Bay for a distance of 10 miles, affording great protection to the river mouth against northerly winds. The width of the bay opposite the river is about 12 miles, and the lower end of Green Bay is about 25 miles south of the river mouth; consequently the natural protection of Oconto Harbor is very great.

The bed of Green Bay contiguous to Oconto Harbor consists of sand superposed on clay, the latter existing at a depth below the water surface of from 12 to 20 feet.

CORPORATE WORK.

The city of Oconto has made an effort to partially improve an artificial entrance from the bay into the river by dredging a cut from the river into the bay at a point about 2,000 feet north of the natural river mouth. This cut has a width of from 50 to 75 feet, and a length of about 1,000 feet, and affords a channel about 4 feet deep at low water. They have further attempted the protection of the mouth of the cut by the construction of 600 linear feet of slab pier on the south and 400 linear feet on the north side. The cost of this work was \$6,262.56. (See Report Chief of Engineers, 1881, page 2067.) These slab piers at the date of the survey were greatly impaired and practically useless, and would require rebuilding to be of value in any plan of improvement for this harbor.

PLANS OF IMPROVEMENT.

In the general consideration of plans for the improvement of Oconto Harbor it will be necessary to first examine the requirements of its commerce.

The vessels engaged in the lumber trade have a draught when loaded of from 12 to 14 feet, and if the object of the improvement is to enable lumber vessels to load directly at the mills of Oconto, then the demands of this class of vessels would decide the character and extent of the improvement, and require the formation of a channel 14 feet deep at low water connecting the deep water of Green Bay with the docks in the city of Oconto. If the object of the improvement is only to enable vessels of light draught to reach the docks at Oconto, but requiring the lumber vessels to anchor in the deep water of Green Bay near the river mouth, and there receive their cargoes from lumber scows of comparatively light draught brought down the river by tugs, then the demands of this method of transportation would require the formation of a channel about 8 feet deep at low water connecting the deep water of the bay with the docks at Oconto. Either plan involves the improvement of the river channel for a distance of about 2 miles. Although in the following estimates the cost of various modifications are given, there seems to be no intermediate requirement between these two plans, since nothing short of the first plan would to any valuable extent promote the second.

From the great natural protection of the mouth of Oconto River less substantial constructions would in part be admissible than at more exposed points. The general plan, as described in Report of Chief of Engineers, 1881, page 2066, proposes the pro-

section of the channel between deep water in Green Bay and the river by slab piers extending to the 6-foot curve, and from thence outward by means of crib-piers; from the connection of this protected channel with the river a dredged channel in the river would be required extending about 2 miles to the city of Oconto. The dredged channel in the river should be as straight as possible, and the curvature of all changes in direction reduced to a minimum; for this reason it seems probable that the abrupt bend in the vicinity of Spie's Slough would be improved by a straight cut connecting to two reaches of the river, especially since the first cost of the improvement by each route is about the same, while the distance by the latter route is reduced by 1,200 feet.

ESTIMATES.

Dredging.

For the formation of a channel connecting the deep water in Green Bay with the proposed entrance to the river, as follows:

	Cubic yards.
Channel 100 feet wide, 10 feet deep at outer end, and 8 feet deep at shore line, dredging.....	70,000
Or 12 feet deep at outer end, 10 feet at shore line, dredging	90,000
Or 14 feet deep at outer end, 12 feet at shore line, dredging	120,000
Or 16 feet deep at outer end, 14 feet at shore line, dredging	150,000

For the formation of a channel in the river extending from the inner end of the piers to Street Street Bridge, in the city of Oconto, would require dredging as follows:

Route.	Depth of channel.				Width of channel.	Slopes.
	8 feet.	10 feet.	12 feet.	14 feet.		
	<i>Cu. yds.</i>	<i>Cu. yds.</i>	<i>Cu. yds.</i>	<i>Cu. yds.</i>	<i>Feet.</i>	
Via river	297,000	402,000	508,000	613,000	100	None.
straight cut	322,000	416,000	511,000	605,000	150	
river	445,000	603,000	762,000	920,000	100	None.
straight cut	484,000	624,000	766,000	908,000	100	1½ on 1.
river	336,000	469,000	603,000	741,000	150	
straight cut	359,000	477,000	598,000	724,000	100	1½ on 1.
river	497,000	684,000	878,000	1,097,000	150	
straight cut	529,000	695,000	868,000	1,066,000	100	2 on 1.
river	353,000	490,000	634,000	783,000	150	
straight cut	374,000	497,000	627,000	763,000	100	2 on 1.
river	514,000	711,000	917,000	1,130,000	150	
straight cut	544,000	719,000	902,000	1,093,000	100	2 on 1.

In estimating the quantity of material to be removed the dredging has always been estimated to a depth of 1 foot below the proposed depth, and 25 per cent. added to place measurement to reduce the quantities to scow measurement.

All depths in this report refer to low water, which is 4 feet below the plane of reference of the lake survey (high water of 1838). This low-water plane is 1 foot below the mean lake level from January, 1860, to January, 1881, and is also 1.2 foot below the mean level for the ordinary season of navigation (April to November, inclusive), from 1860 to 1880, inclusive.

Pier extension.

To extend the piers to the 10-foot curve would require 4,000 linear feet slab-pier and 500 linear feet crib-pier.

To the 12-foot curve would require 4,000 linear feet slab-pier and 900 linear feet crib-pier.

To the 14-foot curve would require 4,000 linear feet slab-pier and 2,000 linear feet crib-pier.

To the 16-foot curve would require 4,000 linear feet slab-pier and 2,700 linear feet crib-pier.

Cost.

Assuming that in the river the channel is dredged 100 feet wide at bottom, with side slopes of 1½ on 1, there would be required—

For an available depth of 8 feet at low water 360,000 cubic yards dredging, at 20 cents	\$72,000
For a 10-foot channel, 477,000 cubic yards, at 20 cents	95,400
For a 12-foot channel, 598,000 cubic yards, at 20 cents	119,600
For a 14-foot channel, 724,000 cubic yards dredging, at 20 cents	144,800

Assuming the channel between the piers to be 100 feet wide, there would be required for a channel having a depth at low water of—

From 8 to 10 feet deep, 70,000 cubic yards dredging, at 25 cents	\$17, 500
From 10 to 12 feet deep, 93,000 cubic yards dredging, at 25 cents	23, 250
From 12 to 14 feet deep, 120,000 cubic yards dredging, at 25 cents	30, 000
From 14 to 16 feet deep, 150,000 cubic yards dredging, at 25 cents	37, 500

In extending the piers there would be required—

To the 10-foot curve:

4,000 linear feet slab-pier, at \$5	20, 000
500 linear feet crib-pier, at \$45	22, 500
	<hr/> 42, 500

To the 12-foot curve:

4,000 linear feet slab-pier, at \$5	20, 000
900 linear feet crib-pier, at \$48	43, 200
	<hr/> 63, 200

To the 14-foot curve:

4,000 linear feet slab-pier, at \$5	20, 000
2,000 linear feet crib-pier, at \$52	104, 000
	<hr/> 124, 000

To the 16-foot curve:

4,000 linear feet slab-pier, at \$5	20, 000
2,700 linear feet crib-pier, at \$54	145, 800
	<hr/> 165, 800

Assembling the foregoing estimate there would be required:

For an 8-foot channel:

River dredging	72, 000
Bay dredging	17, 500
Pier extension	44, 500
Contingencies	14, 000
	<hr/> 148, 000

For a 10-foot channel:

River dredging	95, 400
Bay dredging	23, 250
Pier extension	63, 200
Contingencies	18, 150
	<hr/> 200, 000

For a 12-foot channel:

River dredging	119, 600
Bay dredging	30, 000
Pier extension	124, 800
Contingencies	26, 400
	<hr/> 300, 000

For a 14-foot channel:

River dredging	144, 800
Bay dredging	37, 500
Pier extension	165, 800
Contingencies	33, 900
	<hr/> 382, 000

Very respectfully, your obedient servant,

L. Y. SCHERMERHORN,
Assistant Engineer.

Lient. Col. HENRY M. ROBERT,
Corps of Engineers, U. S. A.
5455—E 83—104

E E 9.

IMPROVEMENT OF PENSAAKKE HARBOR, WISCONSIN.

Estimated cost (see report appended hereto) \$50,000
 Appropriated 10,000

This improvement consists in the construction of a single pier, in extension of the slab-pier built by private enterprise, extending to the 10-foot curve in Green Bay, with the formation of a dredged channel 100 feet wide and 10 feet deep at low water, on the south side of the pier, connecting the deep water in Green Bay with the deep water in the river. The natural approach to the river was not more than 2 feet in depth, but by private work this has been increased to a depth of about 10 feet for a width of 30 feet.

Under date of April 10, 1882, a report was submitted on this harbor, based upon such information as could be obtained without incurring expense (see Report of the Chief of Engineers, 1882, page 2132), in which the estimated cost of the improvement was placed at \$40,000. In September, 1882, a survey was made of the vicinity of the mouth of Pensaukee River, and under date of January 10, 1883, a report was submitted, which is appended hereto, by which the previous estimate of \$40,000 was increased to \$50,000.

Under date of April 16, 1883, a contract was entered into with F. B. Gardner, esq., for the construction of 1,500 (afterward reduced to 1,300) linear feet of slab-pier. This will be the initial work of improvement by the Government at this harbor.

During the fiscal year a survey of the mouth of Pensaukee River and vicinity was made and a commencement made on the construction of the slab-pier, but no part of the same completed. During the present season operations will consist in the completion of the existing contract, under which there yet remains 1,300 linear feet of slab-pier to be built. Continuation of pier extension is the work contemplated during the fiscal year ending June 30, 1885.

Money statement.

Amount appropriated by act passed August 2, 1882.....	\$10,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1883.....	685 15
July 1, 1883, amount available.....	9,314 85
Amount (estimated) required for completion of existing project.....	40,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.....	30,000 00

Abstract of proposals for furnishing labor and materials for building 1,500 linear feet of slab-pier at Pensaukee Harbor, Wisconsin, opened April 3, 1883, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Piles furnished and driven, 14,400 linear feet.	Poles furnished and placed, 300.	Slabs and edgings furnished and placed, 3,400 cords.	Wire, annealed No. 7, furnished and placed, 300 pounds.	Total approximate value of bid.
		<i>Per lin. ft.</i>	<i>Per pole.</i>	<i>Per cord.</i>	<i>Per pound.</i>	
1	W. T. Casgrain, Milwaukee, Wis.....	\$0 25	\$0 75	\$2 50	\$0 08	\$12,240
2	Green Bay Dredge and Pile-driver Company, Green Bay, Wis.....	15	75	2 25	10	10,065
3	F. B. Gardner, Chicago, Ill.....	144	80	2 00	09	9,155

Contract awarded to F. B. Gardner, dated April 16, 1883; in progress.

COMMERCIAL STATISTICS.

Name of harbor, Pensaukee, Wis.
Collection district, Milwaukee, Wis.
Nearest light-house, Tail Point, Wisconsin.

Arrival and departure of vessels during the year ending December 31, 1882.

Description.	Arrivals.		Departures.	
	No.	Tonnage.	No.	Tonnage.
Steamers.....	228	10,500	228	10,500
Sailing vessels.....	75	18,000	75	18,000
Total.....	303	28,500	303	28,500

EXPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Beans*.....bushels..	100	Live stock.....number..	100
Beef*.....pounds..	60,000	Lumber*.....feet, B. M..	10,000,000
Do.....do..	1,550	Do.....do..	5,000,000
Butter.....do..	1,000	Machinery.....pounds..	5,000
Cheese*.....do..	20,000	Posts*.....number..	150,000
Do.....do..	2,400	Do.....do..	1,000,000
Corn*.....bushels..	1,200	Potatoes*.....bushels..	3,000
Eggs*.....dozen..	3,000	Do.....do..	1,000
Do.....do..	500	Rags.....pounds..	2,500
Fish*.....packages..	3,240	Shingles*.....number..	14,480,000
Do.....do..	2,250	Do.....do..	800,000
Furniture.....pieces..	1,000	Slabs*.....cords..	2,500
Hides.....number..	75	Do.....do..	1,200
Household goods.....pounds..	3,000	Ties, railroad.....number..	25,000
Iron.....do..	5,000	Wood*.....cords..	1,000
Live stock*.....number..	200		

IMPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Apples*.....barrels..	100	Iron and steel*.....pounds..	12,000
Do.....do..	50	Do.....do..	2,500
Beef.....pounds..	2,500	Lime*.....barrels..	400
Dry goods*.....tons..	40	Do.....do..	50
Do.....do..	10	Live stock.....number..	40
Feed*.....do..	275	Machinery*.....pounds..	20,000
Do.....do..	70	Do.....do..	40,000
Flour*.....barrels..	1,500	Merchandise, general*.....do..	115,000
Do.....do..	800	Do.....do..	60,000
Fruit.....pounds..	1,000	Oil*.....barrels..	200
Groceries*.....do..	160,000	Pork-barrels*.....number..	300
Do.....do..	80,000	Provisions*.....pounds..	30,000
Hardware.....tons..	10	Salt*.....do..	30,000

The above information was obtained from H. J. Thompson and H. G. Morgan.

SURVEY OF PENSAUKEE HARBOR, WISCONSIN.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., January 10, 1883.

SIR: I have the honor to submit herewith the results of the survey of Pensaukee Harbor made last September.

While the survey indicates no special change since the examination made by Maj. D. C. Houston, Corps of Engineers, in 1872, upon which my report of April 10, 1882, was based, yet the slope of the bottom is so gentle that a very slight difference in the datum plane makes a great difference in the length of the pier required to reach a certain depth of

* Transported by water.

water. The distance between the 10 and 14 foot curves is about 5,000 feet, and between the 10 and 12 foot curves about 4,000 feet.

In the report of the survey of 1872 it was stated that the slab-pier built by private enterprise was 1,000 feet long, whereas last April it was found to be 1,600 feet long. I assumed that the pier had been extended 600 feet since 1872, and consequently in calculating the length of pier required started from a point 600 feet beyond the end of the pier, as shown on the survey of 1872. The present survey shows the outer end of the pier just where it was in 1872, which is 1,600 feet from the old shore line. All else remaining the same this would add 600 feet to the length of the pier as estimated last April from the old survey.

The datum plane for this survey has been taken the same as for the other works in this district, namely, at 6 inches above the low water of the summer of 1847; the datum plane is about 1 foot below the mean lake level for the last twenty years. In reducing the survey of 1872 to this datum it was assumed that the datum plane of the survey was the water level at the time of the survey, and that this level was the same as the mean level of Lake Michigan for that month, as reported by the lake survey. This reduction was only approximately correct, but nothing more accurate could be done with the information that could be obtained without incurring expense.

From these various causes the 14-foot curve is 1,300 feet farther from the head of the present pier than stated in the report last April, the distance being 7,600 feet. It will be time enough to make a plan and estimate for a pier and channel reaching that curve when the interests of commerce demand such an extensive improvement.

As the result of this survey I would have to modify the statement made in my report of last April, that for \$15,000 the 10-foot channel could be extended to the 12-foot curve and deepened to 12 feet; it would require the additional excavation of about 80,000 cubic yards of sand at an estimated cost of \$20,000.

In my report last April I said :

A single slab-pier, 20 feet wide and 2,500 feet long, on the north side of the channel, with a channel 100 feet wide dredged to a depth of 10 feet at low water, and costing about \$40,000, will, in my opinion, answer the present demands of commerce at this place.

I understand the appropriation of funds was made to carry out that plan.

The recent survey shows that the dredged channel beyond the present pier is so far to the north that the pier extension will lie in this channel, thus requiring an increased depth of pier and a larger amount of filling. Fortunately, the 10-foot curve falls inside of where it was supposed to lie, judging from the survey of 1872, so that, instead of the pier extension and dredged channel having to be 600 feet longer than stated in my report (due to the discrepancies in statements of length of pier) it will only have to be 200 feet longer. The last 50 feet of the pier, however, ought to be a crib.

For the cost of obtaining a 10 foot channel 100 feet wide, extending from the shore-line to the 10-foot curve, protected by a single slab-pier (with a crib pier-head) 20 feet wide, I would submit the following :

ESTIMATE.

2,650 feet slab-pier, 20 feet wide, at \$6.....	\$15,900
50 feet crib-pier, 20 feet wide, at \$60	3,000
100,000 cubic yards dredging, at 25 cents	25,000
Superintendence and contingencies	6,100
Total	50,000

The borings show that the bed of the bay at this point is sand, with underlying clay, the clay at the shore-line being 14 feet below datum, and at the 10-foot curve being more than 24 feet.

A tracing of the map of the survey is transmitted herewith.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

E E 10.

IMPROVEMENT OF GREEN BAY HARBOR, WISCONSIN.

Estimated cost (see Report of the Chief of Engineers, 1881, page 2069).....	\$135,000
Appropriated since 1872.....	88,000

This improvement consists in the formation of a dredged channel 200 feet wide at the top and bottom, 14 feet deep at low water, and about 2 miles in length, connecting the mouth of the Fox River with deep water in Green Bay, and including a cut about 650 feet long through Grassy Island revetted with timber.

Expenditures have resulted in the dredging of 652,962 cubic yards of material and the construction of 1,320 linear feet of revetment through Grassy Island. This work has been applied to the formation of a channel over 2 miles in length, 200 feet wide, with about 13 feet depth at low water for one-half its width, and about 10 feet deep over the remaining half.

During the fiscal year, under a contract with Norris G. Dodge, dated September 16, 1882, for the removal of 75,000 cubic yards, 43,524 cubic yards have been removed. During the present season operations will consist in dredging 31,476 cubic yards in completion of the foregoing contract, and also in dredging with the two United States dredges and hired labor to the extent of available funds.

Continuation of dredging is the work contemplated during the fiscal year ending June 30, 1885.

At no distant day the revetment through Grassy Island will require very complete and extensive repairs, its present decayed condition rendering it liable to serious injury from the ice.

Money statement.

Amount appropriated by act passed August 2, 1882	\$20,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$7,091 82
July 1, 1883, outstanding liabilities.....	739 91
	<hr/> 7,831 73
July 1, 1883, amount available	<hr/> 12,168 27
Amount (estimated) required for completion of existing project.....	47,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	40,000 00

1654 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of proposals for dredging at Green Bay Harbor, Wisconsin, opened September 5, 1882, by Maj. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Dredging.
		<i>Per cu. yd.</i>
1	Harry Fox & Co., Chicago, Ill.	\$0 27
2	Carkin, Stiekney & Cram, East Saginaw, Mich.	27
3	Christoph H. Starke, Milwaukee, Wis.	22
4	Green's Dredging Company, Chicago, Ill.	22
5	Green Bay Dredge and Pile-Driver Company, Green Bay, Wis.	17½
6	Norris G. Dodge, Little Falls, N. Y.	17

Contract awarded to Norris G. Dodge, dated September 16, 1882; in progress.

COMMERCIAL STATISTICS.

Name of harbor, Green Bay, Wis.
Collection district, Milwaukee, Wis.
Nearest light-house, Grassy Island, Wisconsin.

Arrival and departure of vessels during the year ending December 31, 1882.

Description.	Arrivals.		Departures.	
	No.	Tonnage.	No.	Tonnage.
Steamers.....	399	87, 819	406	90, 015
Sailing vessels.....	257	83, 915	267	33, 204
Total.....	656	126, 284	673	123, 319

EXPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Bark.....cords..	900	Live stock.....number..	26, 000
Barley.....bushels..	221, 250	Do*.....do.....	240
Do*.....do.....	73, 750	Lumber*.....feet, B. M..	660, 500
Beans.....do.....	4, 750	Machinery,harvesting.pounds.	400, 000
Beef*.....pounds..	17, 000	Do*.....do.....	100, 000
Beer.....barrels..	9, 155	Oats.....bushels..	150, 000
Do*.....do.....	1, 000	Do*.....do.....	35, 878
Butter*.....pounds..	1, 000	Oil*.....barrels..	325
Castings.....do.....	2, 600, 000	Pease*.....bushels..	1, 200
Cheese.....do.....	200, 000	Posts*.....number..	3, 500
Corn.....bushels..	40, 000	Potatoes*.....bushels..	2, 900
Do*.....do.....	700	Rags.....pounds..	1, 250, 000
Blinds,door,and sash.number..	1, 300	Rye.....bushels..	75, 000
Do*.....do.....	2, 600	Do*.....do.....	7, 000
Eggs*.....dozen..	20, 000	Shingles.....number..	6, 297, 000
Fish*.....packages..	4, 782	Stone*.....cords..	25
Fish and pork*.....barrels.	20, 000	Tallow.....pounds..	240, 000
Flour*.....do.....	3, 530	Tools, farm.....tons..	100, 000
Furniture.....pieces..	1, 400	Telegraph poles.....number..	2, 000
Hardware.....tons..	1, 000	Ties,railroad*.....do.....	300
Do*.....do.....	120	Wheat.....bushels..	529, 000
Hides.....number..	20, 000	Do*.....do.....	101, 590
Iron, pig*.....tons..	40, 716	Wood*.....cords..	5, 000
Laths.....number..	171, 000	Wooden ware.....dozen..	4, 100
Leather*.....tons..	19	Wool.....pounds..	40, 000
Lime.....barrels..	2, 300		

* Transported by water.

IMPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Apples*.....barrels..	2, 732	Iron and steel*.....pounds..	616, 000
Bark*.....cords..	9	Leather.....tons..	30
Beef.....pounds..	2, 400	do.....do.....	20
Brick*.....number..	26, 000	Live stock.....number..	2, 000
Coal.....tons..	87, 400	Machinery.....pounds..	400, 000
Dry goods.....do.....	27, 000	do*.....do.....	200, 000
Feed*.....pounds..	5, 000	Merchandise, general....do...	52, 000, 000
Flour*.....barrels..	77	Oil*.....barrels..	8, 764
Groceries.....pounds..	5, 000, 000	Plaster, land*.....pounds..	213, 000
do*.....do.....	1, 000, 000	Provisions*.....do.....	395, 760
Hardware.....tons..	230	Salt*.....do.....	3, 928, 400
do*.....do.....	70	Shingles*.....number..	795, 000
Hay*.....do.....	3	Stone*.....cords..	1, 237
Hides.....number..	24, 000	Wheat*.....bushels..	35, 700
Iron ore*.....tons..	60, 000	Wood*.....cords..	44, 575

The above information was obtained from Mr. F. Hulbert and Mr. Follett.

E E 11.

HARBOR OF REFUGE AT ENTRANCE OF STURGEON BAY CANAL, WISCONSIN.

Estimated cost (see Report of the Chief of Engineers, 1874, I, page 141).... \$180, 000
 Appropriated 150, 000

This improvement consists in the formation of an outer basin, covering the entrance to the Sturgeon Bay and Lake Michigan Ship Canal, by the construction of piers 850 feet apart at the shore line, converging to 335 feet apart at their outer ends, and extending to the 18-foot curve in Lake Michigan; also the deepening of this outer basin by dredging so as to obtain at least 16 feet of water over so much of the area of the basin as would be useful to vessels entering the harbor.

Expenditures have resulted in the construction of 1,600 linear feet of revetted pile-pier, 1,100 linear feet of crib-pier, 330 linear feet of fender-piling, and 38,415 cubic yards of dredging in the outer basin. Of the foregoing 1,100 linear feet of crib-pier, 350 linear feet in the south pier requires two courses of superstructure to bring it to completion, and nearly the entire superstructure over the crib-piers is yet to be filled with stone and covered with plank decking.

A channel about 100 feet wide, and carrying a depth of 16 feet connects the deep water in the lake with the canal. The piers have reached the ultimate extension proposed, and the work yet remaining to be done is the completion of the partially built superstructure and the dredging of the basin.

During the past fiscal year operations have consisted in the removal of 11,379 cubic yards of material from the channel between the piers; this work was done under a contract with the Green Bay Dredge and Pile-Driver Company, dated September 16, 1882. Also, the removal of 9,989 cubic yards by the United States dredge; making an aggregate removal during the fiscal year of 21,368 cubic yards.

From the appropriation for this harbor of August 2, 1882, \$7,000 were set apart to be used, in connection with appropriations from other harbors, in building a dredge, two dump-scows, and the purchase of a tug. This work was completed during the fiscal year; for the details relating

* Transported by water.

thereto see Report on Port Washington Harbor for the fiscal year ending June 30, 1883. In connection with other harbors extensive repairs were also made on the dump-scows and United States Dredge No. 1. To comply with the requirements of Senate resolution of March 9, 1882, a survey was made in October, 1882, of the Sturgeon Bay and Lake Michigan Ship Canal.

During the present season the contemplated operations are, the placing of iron-guard rails on the fender piling, slight repairs to the sheet-pile revetment of the pile-piers, and dredging between the piers by hired labor and use of the United States dredges to the extent of available funds.

Since the construction of the fender piling in July, 1881, experience indicates that the anchor rods, mentioned in the last Annual Report, will not be required to give the piling the requisite stability which it was supposed to lack, consequently their omission, for the present at least, is proposed. The anchor rods are on hand and if at any time their necessity should arise they can be then placed in position.

During the fiscal year ending June 30, 1885, it is proposed to complete the superstructure over the crib-piers and also the dredging in the outer basin.

Under the requirements of the Senate resolution of March 9, 1882, a Board of Engineers was constituted by Special Orders No. 51, Headquarters of the Corps of Engineers, to report on the cost of constructing the Sturgeon Bay and Lake Michigan Ship Canal, and also to ascertain the amount of money realized by the company from the sale of lands granted by the State of Wisconsin in aid of the construction of the canal. The report of the Board is appended hereto.

Money statement.

July 1, 1882, amount available	\$22 47
Amount appropriated by act passed August 2, 1882	20, 000 00
	20, 022 47
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$9, 029 12
July 1, 1883, outstanding liabilities	2, 634 75
	11, 663 87
July 1, 1883, amount available	8, 358 60
Amount (estimated) required for completion of existing project	30, 000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885 ..	30, 000 00

Abstract of proposals for dredging at harbor of refuge at entrance of Sturgeon Bay Canal, Wisconsin, opened September 5, 1882, by Maj. Henry M. Robert, Corps of Engineers.

No.	Names and residences of bidders.	Dredging.
		<i>Per cu. yd.</i>
1	Carkin, Stickney & Cram, East Saginaw, Mich.	\$0 39
2	Harry Fox & Co., Chicago, Ill.	29
3	Truman & Cooper, Manitowoc, Wis.	28
4	Green's Dredging Company, Chicago, Ill.	27
5	Christoph H. Starke, Milwaukee, Wis.	26
6	Green Bay Dredge and Pile-Driver Company, Green Bay, Wis.	19

Contract awarded to Green Bay Dredge and Pile-Driver Company, dated September 16, 1882; closed November 17, 1882.

COMMERCIAL STATISTICS

Number of vessels and their tonnage which passed through the Sturgeon Bay Ship Canal during the year ending December 31, 1882.

Description.	No.	Tonnage.
Steamers and sailing vessels.....	3, 050	745, 134

The above information was obtained from Mr. G. H. Sager, superintendent.

STURGEON BAY AND LAKE MICHIGAN SHIP CANAL.

REPORT OF BOARD OF ENGINEERS.

MILWAUKEE, WIS., *December 19, 1882.*

GENERAL: The Board of Engineers constituted by Special Order No. 51, Headquarters Corps of Engineers, dated Washington, D. C., June 6, 1882, to consider and report the information called for by the following Senate resolution, namely:

IN THE SENATE OF THE UNITED STATES,
March 9, 1882.

Resolved, That the Secretary of War be, and he hereby is, instructed to ascertain and report to Congress at its next session, the cost of constructing the Sturgeon Bay and Lake Michigan Ship Canal, in the State of Wisconsin, and by whom said ship canal was constructed; also, to ascertain the amount of money realized from the sale of the lands granted by Congress to the State of Wisconsin to aid in the construction of said ship canal; said information being required for the purpose of considering the question of opening said ship canal free to the commerce of the lakes.

F. E. SHOBER,
Acting Secretary.

has the honor to submit the following report:

In 1866, the United States granted to the State of Wisconsin 200,000 acres of land to aid in the construction of a breakwater and a harbor and ship canal, to connect the waters of Green Bay with the waters of Lake Michigan. The act is as follows:

CHAPTER 32.—An act granting to the State of Wisconsin a donation of public lands to aid in the construction of a breakwater and harbor and ship canal at the head of Sturgeon Bay, in the county of Door, in said State, to connect the waters of Green Bay with Lake Michigan, in said State.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there be, and hereby is, granted to the State of Wisconsin, for the purpose of aiding said State in constructing and completing a breakwater and harbor and ship canal to connect the waters of Green Bay with the waters of Lake Michigan, two hundred thousand acres of public lands, to be selected in subdivisions agreeably to the United States survey, by an agent or agents appointed by the governor of said State, subject to the approval of the Secretary of the Interior, from lands subject to private entry: *Provided,* That said selections shall all be made from alternate and odd-numbered sections of land nearest the location of said harbor and canal in said State not otherwise appropriated, and not from lands designated by the United States as "Mineral" before the passage of this act, nor from lands to which the rights of pre-emption or homestead have attached.

SEC. 2. *And be it further enacted,* That the said lands hereby granted shall be subject to the disposal of the legislature of said State, or, if the legislature thereof shall not be in session, or shall adjourn within ten days after the passage and approval of this act, then said lands shall be subject to the disposal of the governor and board of commissioners of school, university, and swamp lands of said State, for the purposes aforesaid, and for no other; and the said canal shall be and remain a public highway for the use of the Government of the United States, free from toll or charge upon the vessels of said Government, or upon vessels employed by said Government in the transportation of any property or troops of the United States.

SEC. 3. *And be it further enacted*, That before it shall be competent for said State to dispose of any of said lands, to be selected as aforesaid, the plan of said breakwater and harbor and the route of said canal shall be established, and a plat or plats thereof shall be filed in the office of the War Department, and a duplicate thereof filed in the office of the Commissioner of the General Land Office.

SEC. 4. *And be it further enacted*, That if the said breakwater, harbor, and canal shall not be completed within three years from the passage of this act the lands hereby granted and remaining unsold shall revert to the United States.

SEC. 5. *And be it further enacted*, That the legislature of said State shall cause to be kept an accurate account of the sales and net proceeds of the lands hereby granted, and of all expenditures in the construction, repairs, and operating of said canal, and of the earnings thereof, and shall return a statement of the same annually to the Secretary of the Interior. And whenever said State shall be fully reimbursed for all advances made for the construction, repairs, and operating of said canal, with legal interest on all advances until the reimbursement of the same, or upon payment by the United States of any balance of such advances over such receipts from said lands and canal, with such interest, the said State shall be allowed to tax for the use of said canal only such tolls as shall be sufficient to pay all necessary expenses for the care, charge, and repair of the same.

SEC. 6. *And be it further enacted*, That said ship canal shall be at least one hundred feet in width, with a depth of water not less than thirteen feet.

Approved April 10, 1866.

This grant was accepted by the State of Wisconsin and turned over to the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company by the following act:

GENERAL LAWS OF WISCONSIN, CHAPTER 105.

[Published March 10, 1868.]

AN ACT to accept a grant of lands made to the State of Wisconsin by act of Congress to aid in the construction of the Sturgeon Bay and Lake Michigan Ship Canal and Harbor, in the county of Door, to connect the waters of Green Bay with Lake Michigan, and to provide for the construction of the same.

The people of the State of Wisconsin, represented in senate and assembly, do enact as follows:

SECTION 1. That the lands, franchises, rights, powers, and privileges granted to and conferred upon the State of Wisconsin by an act of Congress approved April 10, 1866, "granting to the State of Wisconsin a donation of public lands to aid in the construction of a breakwater and harbor and ship canal at the head of Sturgeon Bay, in the county of Door, in said State, to connect the waters of Green Bay with Lake Michigan, in said State," be, and the same are hereby, accepted, with the restrictions and upon the terms and conditions contained in said act of Congress.

SECTION 2. For the purpose [of] carrying out the objects of said act, the said lands are hereby granted and conferred upon the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company, a company organized in the city of Milwaukee on the 4th day of October, 1866, under and by virtue of chapter 365 of the laws of Wisconsin of 1864, approved April 24, 1864, subject to all the conditions, restrictions, and obligations herein mentioned.

SECTION 3. It shall be the duty of said ship-canal company to appoint an engineer who shall proceed to survey, lay out, and establish the route of said canal and determine the termination thereof, and also prepare a plan for the construction of said canal in conformity with the provisions of the said act of Congress, and make a diagram thereof to be approved by the governor, and when approved by him the same shall be filed in the office of the secretary of state.

SECTION 4. It shall be the duty of the said company, after having made and filed such survey and plan of said canal, to proceed without unnecessary delay and construct the same in conformity therewith: *Provided*, That as the work on said canal progresses, the company may notify the governor that one-fourth or one-half or three-fourths of said work has been done, respectively, when upon receiving such notification, the governor shall appoint an agent to inspect the same, and if said governor is satisfied that so much of said work has been done in accordance with the requirements of this act and of the act of Congress aforesaid, then the said governor shall certify the same to said company and deposit a copy thereof in the office of the secretary of state, and in said certificate shall determine the proportion of said lands the said company has become entitled to in consideration of said work so done and approved by said governor, and when the governor shall make and file such certificate the commissioners of schools and university lands shall convey by patent to the said company said proportions of said lands, respectively, as selected by said company,

and said company may proceed to sell and convey the same, and when the said company shall have completed the said canal in pursuance of the act of Congress, and in conformity with said survey and plan, it shall be the duty of the company's engineer to certify the same to the governor, whereupon it shall be the duty of the governor to inspect the said work in person, or to appoint one or more agents to inspect the same and determine whether the said canal is constructed as required by this act. And whenever the said governor shall determine that the said canal has been constructed by the said company as required by said act of Congress, and in conformity with the plan aforesaid, he shall certify the same to said company and deposit a copy thereof in the office of the secretary of state, and which certificate, as well as any certified copy thereof, or of any other certificates, mentioned in this act, under the seal of the State, shall be evidence of the facts therein set forth. And when the governor shall make and file with the secretary of state such certificate, and deliver a copy of the same to the said company, the remainder of said lands shall be patented by the commissioners of school and university lands to the said company, which shall stand seized and possessed of all said lands as fully as the State can convey the same and free from any tax for the term of ten years, if so long held by the said company, and the said company shall use all due diligence in disposing of said lands at a fair and equitable price, and they shall not be held by the said company for speculation, and when sold by said company they shall be subject to taxation: *Provided*, That previous to the issue of a patent therefor, or for any of said lands, said company shall reimburse the State for all expenses incurred on account of the same.

SECTION 5. All expenses incurred under and by virtue of this act, and of the act of Congress aforesaid, shall be paid by the company, and the State shall not in any wise be holden therefor.

SECTION 6. This act shall take effect and be in force from and after its passage.

Approved March 5, 1863.

By the terms of the fourth section of the act of Congress making the grant, all unsold lands reverted to the United States, if the canal, &c., were not completed in three years. The canal was not commenced for six years, the grant being revived by an act approved March 1, 1872, extending the time for completing the canal to the 10th day of April, 1874, and at that date the first quarter of the canal had not been completed, nor had any land been sold. It would seem that additional legislation is needed in this matter.

On the 3d of March, 1873, the United States undertook the construction of what was termed a harbor of refuge, at the entrance of the Sturgeon Bay Canal, which relieved the State of Wisconsin of a part of the work required by the original act.

I. Upon application to the governor of Wisconsin, the Board was informed that the canal was constructed by the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company, which is the company referred to in the above act of the legislature of Wisconsin, and which appears to have acted as the agent of the State of Wisconsin in building the canal.

On the 9th of July, 1872, work was begun on the canal, and the first quarter was completed November, 1874. The work was suspended until 1877, when it was resumed and prosecuted to completion in November, 1881, the governor's certificate of completion of the canal being dated December 5, 1881.

The State required the canal to be 100 feet wide at the water's surface, with side slopes of 1 vertical to 1½ horizontal, and a depth of 13 feet, measured from the low water of 1847. The State inspector, in his final report of December 1, 1881 (which is appended hereto, marked B), says that the greater part of the canal had been dredged to a depth of 15 and 16 feet at low water.

A survey of the canal from Lake Michigan to the shore of Sturgeon Bay was made during the month of October, 1882, under the direction of the officer in charge of the harbor of refuge at entrance of the canal, that the Board might ascertain the present condition of the canal. A map of this survey is forwarded herewith. From it will be seen that the canal

is 100 feet wide at the water's surface; that the 3,200 feet nearest the Lake Michigan end is revetted with sheet piling on both sides; that the next 900 feet is protected on both sides with brush and a few piles, and that the remaining 3,300 feet of canal up to the Sturgeon Bay shore is unprotected. From the Sturgeon Bay shore out to the 13-foot curve in Sturgeon Bay, a distance of 6,100 feet, the channel has been dredged as deep as the rest of the canal. The canal, for a width of 50 feet, has a general depth of 13 feet, except for a short distance near the middle of the canal, where it has shoaled up to 11 feet, both depths being measured from the low water of 1847.

II. As section 5 of the act of Congress making the grant requires the legislature of Wisconsin to cause to be kept an accurate account of the sales and net proceeds of the lands granted, the Board applied to the governor of the State of Wisconsin for a copy of this record.

The governor, in reply, informed the Board that the canal was built by the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company, and that there is no public record of what the company realized for the land grant. There being no other source of information on this point, the Board, on the 14th of July, 1882, applied to the president of the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company, and, under date of October 10, was informed that their total receipts from the land grant of 200,000 acres were (see Statement D, hereto appended) \$377,965.22, and the total expenses of the land department were \$33,278.05, leaving \$344,687.17 as the net sum realized from the land grant on the 10th of October, 1882. There was at that date due the company on the land account \$1,182.84, but this will probably add but little if anything to the net amount realized, for a statement of the company one month later than the above (November 8) shows \$273.78 received from collections in the land department, while the expenses of the same department for the month were \$453.16.

III. Section 5 of the act of Congress making the land grant requires the legislature of Wisconsin to cause to be kept an accurate account of all expenditures in the construction, repairs, and operating of the canal, and of the earnings thereof. The Board applied to the governor of the State for a copy of this record, and received a reply that no such record was on file. The Board then applied to the canal company, who furnished a statement of the receipts and disbursements of the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company, from May 7, 1872, to October 10, 1882, certified to by Jesse Spalding, president, and William E. Strong, treasurer and assistant secretary. (See Statement D, hereto appended.) According to this statement, the entire disbursements under the canal construction account, including \$36,510.61 for the expenses of the office of the chief engineer and superintendence and \$1,016.83 for repairs, were \$342,762.99.

The receipts for canal tolls and towing for the portion of the season of 1882 to September 30 amounted to \$14,016.76, from which deducting the operating expenses as per statement referred to, amounting to \$8,542.30, there is left a net profit of \$5,474.46 from these sources. Previous to 1882 the canal had not been accepted by the State, so the tolls are not reported as received by the company.

The Senate resolution calls for a statement of the cost of constructing the canal. As there is room for difference of opinion as to what properly comes under the head of "cost of constructing the canal," the Board thought it better to obtain from the canal company a complete statement of receipts and disbursements of the canal company, which was furnished up to October 10, 1882. (Appended hereto, marked

D.) According to this statement there were, in addition to those already mentioned, the following expenses:

Organization and bond expense accounts	\$10,669 25
General expense account (Chicago office)	22,828 92
Interest account	12,974 32
Miscellaneous expenses (United States light-house department), \$370.39,	
less miscellaneous receipts, \$351.03	19 36
Advances on land contracts sold	393 27
	<hr/> 46,885 12

As the net receipts from the land grant and tolls and towing exceeded the entire disbursements for canal construction and repairs and operating expenses by \$7,398.64, this would make the entire disbursements exceed the receipts to October 10, 1882, by \$39,486.48.

In determining the question as to how much of these disbursements can legitimately be charged to the cost of constructing the canal the Board would refer to the majority and minority reports of the committee of the Wisconsin legislature, published in the Annual Report of the Chief of Engineers, United States Army, for 1879, pages 1494-1505. In the majority report, page 1497, is the following:

The last charge which we shall here notice is that the principal office of the [canal] company is not kept in Wisconsin in accordance with the requirements of the statute. The officers claim that they have an office in Milwaukee which is the only distinctive office which the company has. The president, secretary, and treasurer draw no salary, and perform such official acts as devolve upon them at their private offices. The land department is under the charge of D. W. Maxon, and the superintendence of the construction of the canal is under the charge of the chief engineer, Capt. W. T. Casgrain, both of whom have an office at 102 Wisconsin street, Milwaukee, which is rented and paid for by the company.

The expenses of the Milwaukee office here referred to, as well as all other expenses connected with the land and engineer departments, have been included in the statements heretofore made as to the net receipts from the land grant and the total disbursements for constructing the canal.

At the close of the statement of receipts and disbursements of the canal company is the following remark:

In the foregoing statement no interest has been charged on the money advanced by the stockholders in 1872 and 1873.

We will furnish in a few days a detailed statement of the interest account on the moneys advanced, from the date of such advances to the present time at the current rates.

No charge has been made in the foregoing accounts for services rendered by the officers of the company having the work in charge since 1872, other than the Chief Engineer and Land Commissioner, except the sum of \$6,250 paid the treasurer and assistant secretary for a portion of the time.

The Board wrote for this additional information, and finally received a detailed statement of interest account (marked E) and a supplementary statement of receipts and disbursements, dated November 8, 1882 (marked F). It appears to the Board that the object of section 5 of the act granting the land to aid in the construction of the canal could be entirely defeated if salaries for the various officers of a corporation could be charged as a part of the expenses of the State "for the construction, repairs, and operating of said canal."

In conclusion, the Board would summarize this report by saying that, from the available information, the Sturgeon Bay and Lake Michigan Ship Canal was built by the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company, under a charter of the State of Wisconsin; that they realized from the land grant of 200,000 acres a net sum of \$344,687.17, and that the cost of construction of the canal, including

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engineering, superintendence, and the expenses of the officers in Wisconsin and repairs, was \$342,762.99.

As the Senate resolution calls for this information "for the purpose of considering the question of opening said ship canal free to the commerce of the lakes," and the letter of instructions directs the Board to "procure such information as in its judgment may be necessary to a proper investigation of the subject," the Board obtained from the canal company full statements of receipts and expenses and moneys advanced, with interest charged, and the amounts that they would expect to receive in case the Government should decide to take control of the work. This latter amount is \$178,168.58. The method of arriving at this amount will appear from the statements which, with other papers, are appended to this report as follows:

Map* of survey of Sturgeon Bay and Lake Michigan Ship Canal made for the Board, October, 1882.

(A) Certificate of the governor of the State of Wisconsin of the completion of the Sturgeon Bay and Lake Michigan Ship Canal.

(B) Final report of the State inspector on the Sturgeon Bay and Lake Michigan Ship Canal.

(C) Letter of the president of the Sturgeon Bay and Lake Michigan Ship Canal Company, dated October 10, 1882, forwarding certain papers to the Board and explaining certain disbursements.

(D) Statement of receipts and disbursements of the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company from May 7, 1872, to October 10, 1882.

(E) Statement in detail of interest paid by the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company from May 7, 1872, to October 10, 1882, as appearing in statement of receipts and disbursements (D).

(F) Statement of the total cost of the Sturgeon Bay and Lake Michigan Ship Canal, including interest on advances made by the stockholders and expenses incurred in managing canal to December 1, 1882.

(G) Letter of the president of the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company explanatory of Statement F.

(H) Statement in detail of cash advances by stockholders in 1872 and 1873 to the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company, as appearing in statements F and G.

(I) Statement of the number and tonnage of vessels passing through the Sturgeon Bay and Lake Michigan Ship Canal for the seasons 1879, 1880, and 1881, and to October 1, 1882.

(K) Statement supplementary to Statement I.

Respectfully submitted.

D. C. HOUSTON,
Lieutenant-Colonel of Engineers, Brevet Colonel.
HENRY M. ROBERT,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

A.

CERTIFICATE OF THE GOVERNOR OF THE STATE OF WISCONSIN OF THE COMPLETION
OF THE STURGEON BAY AND LAKE MICHIGAN SHIP CANAL.

UNITED STATES OF AMERICA:

The State of Wisconsin. William E. Smith, governor. To all to whom these presents shall come, greeting:

Whereas it appears by the report of the agent appointed by me to inspect the work done on the Sturgeon Bay and Lake Michigan Ship Canal, bearing date the 1st instant, that said canal has been completed in accordance with the requirements of the act of

* Omitted. Printed in Senate Ex. Doc. No. 34, Forty-seventh Congress, second session.

Congress approved April 10, 1866, and of the acts of the legislature of the State of Wisconsin relating thereto:

Now, therefore, I, William E. Smith, governor of the State of Wisconsin, do hereby certify that the Sturgeon Bay and Lake Michigan Ship Canal has been completed, as required by the acts aforesaid, and in conformity with the established plans duly approved; and that in consideration thereof, the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company is entitled to a patent for the remainder of the lands granted by said act of Congress to aid in the construction of said canal.

In witness whereof I have hereunto set my hand and caused the great seal of the State of Wisconsin to be affixed. Done at the capitol, in the city of Madison, this fifth day of December, in the year of our Lord one thousand eight hundred and eighty-one.

[SEAL.]

WILLIAM E. SMITH.

By the governor:

HANS B. WARNER,
Secretary of State.

UNITED STATES OF AMERICA,
State of Wisconsin, Department of State, ss:

To all to whom these presents shall come:

I, Ernst G. Timme, secretary of state of the State of Wisconsin, do hereby certify that the foregoing copy of certificate by the governor, of the completion of the Sturgeon Bay and Lake Michigan Ship Canal, has been compared by me with the original certificate, in this department, and that the same is a true copy thereof, and of the whole of such original.

In testimony whereof I have hereunto set my hand and affixed my official seal, at the capitol, in the city of Madison, this nineteenth day of July, A. D. 1882.

[SEAL.]

ERNST G. TIMME,
Secretary of State.

B.

FINAL REPORT OF THE STATE INSPECTOR ON THE STURGEON BAY AND LAKE MICHIGAN SHIP CANAL.

MADISON, WIS., December 1, 1881.

GOVERNOR: I have the honor to inform your excellency that I have, in obedience with your instructions dated November 18, 1881, visited the "Sturgeon Bay and Lake Michigan Ship Canal," and having examined and inspected the same, beg leave to submit the following statements and report:

The canal is completed in accordance with the acts of Congress, and of the legislature of the State of Wisconsin, which require a canal of 100 feet wide at the water surface and of 13 feet deep, without any special reference to details or mode of construction, the State having this matter in trust has presumed to construe the action of Congress and of the legislature, as requiring a canal of the above dimensions constructed on such plan and in such manner as would promise to give a work of reasonable permanence.

It was at first supposed that the canal cut would stand without revetment of the banks, but as the work progressed it was found that nearly one-half the length of the dry cutting (the whole length is 7,300 feet), where the banks were high and the subsoil of pure sand, required revetment. The company has put in this revetment in the most substantial manner. The length of this revetment in the canal is 3,200 feet on each side of the Lake Michigan end; the company has also put in similar revetment outside of the canal extending from the mouth of the canal to the government piers 750 feet on the lake front. In the canal beyond the revetment the subsoil is of a sandy marl overlaid with sand. The marl withstood the action of the waves, but the sand yielded, causing a caving of the banks. To prevent this wearing and consequent filling of the channel, the company has put in a brush protection for a distance of 700 feet on each side. This protection is built by driving piles in line 6 feet apart; the brush is made in bundles 10 to 12 feet long; a number of these fascines are laid lengthwise behind the piles to the height of water surface, then in layers slightly oblique to a right angle with the canal; the tips are placed against the banks so that the butts form a wall along the canal; the brush is loaded with driftwood to keep the same in place until securely matted in with sand, which will hold them securely in place. Beyond the terminus of the brush protection, the marl banks are sufficiently stable to prevent washing or caving by wave action. The cut in the flats at the head of Sturgeon Bay preserves its depth, showing that there is no wear of the submerged banks.

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There is a bend in the cut in the bay 4,000 feet northwest from canal. Here the company has dredged a very wide channel in order that vessels may turn or pass each other without danger of collision.

A great source of annoyance during the progress of the work was the presence of much surface water, which continually trickled out from and undermined and let down large sections of the highest banks; this has been entirely remedied by sloping the surface from the canal to back drains which convey a great deal of water. These drains are from 10 to 25 feet wide, running parallel with the canal, and emptying into the bay near the canal.

While making this examination I was enabled to observe the practical operating of the canal by various classes of vessels and under variable conditions of wind and weather.

From my own observation and examination of the toll-books of the canal I am enabled to insert here in tabular form the operations of commerce through the canal and amount of lumber carried in various ways. The canal was much obstructed by dredges during the greater part of the season, otherwise the number of passages would be greater.

1881.	Steamers, freight and passenger.	Sailing in.	Vessels out.	Total sail vessels.	Tugs.
April.....		12	6	18	5
May.....	13	85	67	152	90
June.....	4	165	117	282	184
July.....	8	190	117	307	219
August.....		185	113	298	207
September.....	1	138	80	218	160
October.....	1	165	85	250	139
November, to 24th.....		91	72	163	117
Total.....	27	1,031	657	1,688	1,121

The number of tug-boats given are only those towing vessels in or out. The total number of sailing vessels is 1,688, while the number of tows is only 1,121, from which it will be seen that 567 sailing vessels made the passage without tugs and with safety. The total tonnage of vessels passing was 350,000 tons; 306 vessels carried 84,000,000 feet of lumber; 2,500,000 was passed in rafts, and 2,168,000 on scows; 2,265 tons of building stone passed the canal by sail. The number of logs, ties, shingles, and other merchandise could not readily be ascertained. Among some of the larger vessels passing are the following: Schooner George Murray, 790 tons register; steamer Oconto, 506 tons register; United States steamer Andrew Johnson, 499 tons register.

The steamer Mantenece passed through on November 12, drawing 13 feet 2 inches. Many of the larger vessels passing draw from 10 to 13 feet.

Of vessels now trading in the canal, 55 have run in for refuge from Lake Michigan, 16 in September, 25 in October, and 14 in November. There is no doubt but some of these would have been lost had they not had this refuge at hand. The total number of vessels which passed through the canal in 1880, while yet in an unfinished condition, was 533, with a tonnage of 113,497 tons.

On the 25th of this month the steam barge Bismarck, with three large lumber barges in tow, parted her tow-line on Lake Michigan, only a few miles from the canal; the sea was so great that she was unable to pick them up again, neither was there a tug at hand to give assistance; the barges set sail, made the harbor, and succeeded in running into the canal. The foregoing will show that the canal is completed and in successful operation, and there is no doubt that traffic will increase in a short time. The channel for the greater part is dredged to a depth of 15 and 16 feet below low water, which will take up any filling which may occur from wind, drifts, or currents, for a considerable time. Although this work is a success as a highway, it is not what it should be as a harbor of refuge. The outer harbor is insufficient as a harbor of refuge for several reasons. In the first place, it is entirely too small for anything like the fleets which were forced to seek refuge in the canal during the season just passed, and in the second place, if it was larger it is a question if it would be any more tenable than it is now. The piers are completed to the full extent as they were designed, with some additional work beyond the pier heads to make the entrance safer and surer. In the basin there is as yet only a narrow channel by which vessels can enter, the remainder is nearly the same as the natural lake bottom, with 7 to 10 feet of water; the storm waves from the lake enter with great momentum, which, meeting with resistance in shallow water, is converted into vertical motion, creating great disturbance so as to make it entirely untenable for vessels. It is possible that this may be remedied to a great extent by dredging out the basin and rendering the entrance to the canal safer and easier than at present, but vessels seeking refuge will have to enter the canal.

During the season just passed, the canal was fairly lined with vessels for a long distance, thereby rendering it difficult and dangerous for other vessels to enter and pass. If they run through, they must go to the bay, three or four miles, and pay both towage and toll. To avoid this, they remain in the canal, where there is not room for them.

I venture these rather lengthy remarks to explain what I have seen from actual observation, that is, that there is no harbor of refuge in the true sense of the word. It is important that there should be one. The canal can be operated and maintained, but since the canal company have fulfilled their obligations this will have to be done from the tolls collected, and it is a question if these will be sufficient to settle damages in addition to making repairs if the canal is used as a refuge as it has been.

To construct an outer harbor would involve great expense, and should the Government dredge out a basin at the inner end there would still be the difficulty about canal tolls, which could only be settled by action of Congress.

It would, in my opinion, be to the interest of commerce if the United States would assume control of this important work as early as possible, in fact at once, for there is no doubt that it will have to come to this sooner or later, and the sooner the better in every respect. It may, in fact, have been a mistake in the first place for the Government to have let this work go out of its hands, and the best it can do is to get it back while it is yet new and in good condition. There is no doubt, it has, in fact, already been sufficiently demonstrated that this canal is destined to be a great commercial highway, and if in the control of the General Government, the tolls can be removed from vessels seeking refuge and a suitable safe harbor can be constructed at the head of Sturgeon Bay at a very moderate cost.

I feel safe in saying that with the increasing commerce in this highway, the Government could in a few years at furthest reduce the tolls to a minimum, making the canal virtually free, a great desideratum to lake commerce and the development of our natural resources.

The canal company can have no serious, or in fact any, objection to the change suggested above, for, having completed the work according to law, it has no further pecuniary interest; the tolls collected must be accounted for and be paid to the Government until the same is reimbursed the value of the grant.

In conclusion, I will state that my survey, examination, and observations in accordance with instructions for final inspection, show that the canal is now completed in such a manner that the company is lawfully entitled to all the benefits provided by the acts of Congress and of the legislature.

Respectfully submitted.

JOHN NADER,

Agent for the State Inspector of Canal.

To his Excellency WILLIAM E. SMITH,
Governor of Wisconsin.

UNITED STATES OF AMERICA,
State of Wisconsin, Department of State, ss :

To all to whom these presents shall come:

I, Ernst G. Timme, secretary of state of the State of Wisconsin, do hereby certify that the annexed copy of the report by John Nader, agent for State inspector, of the completion of the Sturgeon Bay and Lake Michigan Ship Canal, has been compared by me with the original report in this department, and that the same is a true copy thereof, and of the whole of such original report.

In testimony whereof, I have hereunto set my hand and affixed my official seal at the capitol, in the city of Madison, this nineteenth day of July, A. D. 1882.

[SEAL.]

ERNST G. TIMME,
Secretary of State.

C.

LETTER OF THE PRESIDENT OF THE STURGEON BAY AND LAKE MICHIGAN SHIP CANAL COMPANY TO THE BOARD OF ENGINEERS.

CUSTOM-HOUSE, CHICAGO, ILL.,
Collector's Office, October 10, 1882.

GENTLEMEN: I forward to you to-day statement of the Canal Company's receipts and disbursements, &c., from May 7, 1872, to date (October 10); also statement showing in detail the sales of the land grant of about 200,000 acres; also a statement of the number of vessels passing through the canal during the years 1879, 1880, 1881, and to October 1, 1882. In further explanation of the item of \$877.30 paid the contractor, O. B. Green, in 1882, being 5 cents per yard on 17,546 yards of material removed by the Green Bay Dredging and Driving Company in 1879, I wish to say: Under a misapprehension of the terms of the company's contract with Mr. O. B. Green, a contract

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was awarded to the Green Bay Company to do some dock work on the canal, in connection with which there were several thousand yards of material to be removed. Mr. O. B. Green, the contractor, claimed that under the terms of his contract with the company he was to do all the piling, docking, and dredging. His contract price for dredging was 20 cents per yard. Upon a careful examination of the contract it was decided that Mr. Green was right. However, he waived his claim so far as the docking was concerned, but claimed the difference between 15 cents and 20 cents per yard for the number of yards necessary to remove to construct said dock. In order to settle the matter satisfactorily with all parties, the canal company agreed to pay the Green Bay Company 15 cents and Mr. Green 5 cents per yard. By an oversight on Mr. Green's part, his claim was not presented until recently, when it was adjusted and paid in accordance with the agreement made in 1879.

Very truly yours,

JESSE SPALDING,
President.

Col. D. C. HOUSTON and Maj. H. M. ROBERT,
United States Engineers.

D.

STATEMENT OF RECEIPTS AND DISBURSEMENTS OF THE STURGEON BAY AND LAKE MICHIGAN SHIP CANAL AND HARBOR COMPANY, FROM MAY 7, 1872, TO OCTOBER 10, 1882.

Cash receipts from May 7, 1872, to October 10, 1882.

Received from capital stock:

During 1872, 5 per cent. paid on 359 shares	\$1,795 00
During 1873, 95 per cent. paid on 6 shares	570 00
During 1878, sale of three shares	300 00
Total	\$2,665 00

Cash loans paid with stock at par:

1872-'73, from the Peshtigo Company	26,785 69
1872-'73, from Jesse Spalding	10,732 55
1872-'73, from Isaac Stephenson	10,732 55
1872-'73, from F. B. Gardner	10,732 55

Total loan in cash **58,983 34**

Total from capital stock of company **61,648 34**

From trespasses on land grant and sales of dead and down timber, being collections by timber clerks and assistants:

During 1872, from State treasurer of Wisconsin	26,021 17
During 1873, from State treasurer of Wisconsin	9,475 89
During 1874, from State treasurer of Wisconsin	2,941 63
During 1875, from State treasurer of Wisconsin	1,617 80
During 1876, from State treasurer of Wisconsin	526 08
During 1877, from State treasurer of Wisconsin	2,833 43
During 1878, from State treasurer of Wisconsin	2,834 26
During 1879, from State treasurer of Wisconsin	1,298 65
During 1880, from State treasurer of Wisconsin	467 29
During 1881, from State treasurer of Wisconsin	105 00

48,121 20

From lands prior to patents from State:

During 1880, on lands patented to company	1,284 62
During 1881, on lands patented to company	3,637 13

Total realized from trespasses, &c **53,042 95**

Realized from sale of land grant—from sales of lands patented to canal company:

Collections and sale of contracts during 1877	90,945 16
Collections and sale of contracts during 1878	70,094 96
Collections and sale of contracts during 1879	47,081 25
Collections and sale of contracts during 1880	34,679 91
Collections and sale of contracts during 1881	56,207 69
Collections and sale of contracts during 1882	21,913 30

Total from sales of land grant **324,922 27**

Realized from first-mortgage bonds issued and paid to Green, Fox & Howard, contractors, December, 1874, canceled and paid April 24, 1877	\$8,000 00
Realized from canal tolls and towing, collections from vessels for toll and towing, from March, 1882, to September 30, 1882	14,016 76

Receipts from miscellaneous sources:

From Chicago and Northwestern Railway Company in 1879, for right of way through canal lands	\$150 00
From dockage on ties, posts, &c., landed on bank of canal in 1880	82 78
Landed on bank of canal in 1881	118 25
Total from miscellaneous sources	351 03
Total receipts from May 7, 1872, to October 10, 1882	461,981 35

*Disbursements from May 7, 1872, to October 10, 1882.***Canal construction account, on vouchers of chief engineer on file.****Dredging, dry and wet excavation:**

Axtell, Harris & Gutches, 1872, 191,035 yards, at 30 cents	\$57,310 50
The Peshtigo Company, 1873, 40,983 yards, at 30 cents	12,294 90
F. B. Gardner, 1873, 32,047 yards, at 30 cents	9,626 10
Green, Fox & Howard, 1874, 24,649 yards, at 33 cents	8,134 17
* Green Bay Dredge and Pile-Driver Company, O. B. Green, 1879, 17,546 yards, at 20 cents	3,509 20
O. B. Green, 1877-'81, 841,324½ yards, at 20 cents	168,264 95
Total, 1,147,624½ yards, costing	\$259,139 82

Clearing, grubbing, and draining route of canal:

1872-'73. Lawrence & Foss, clearing	3,230 00
1873. William E. Strong, contractor, clearing and draining	1,188 06
1878. O. B. Green (paid in 1882), clearing, &c.	178 33
	4,596 39

Docking Lake Michigan entrance:

1879. Green Bay Dredging and Pile-Driver Company, 690 feet, at \$3.95 and \$4.75	2,964 00
1880-'81. O. B. Green, 601 feet, at \$7.25	4,357 25
	7,321 25

Revetment from Lake Michigan, west:

1880. O. B. Green, 3,022 feet, at \$5.25	15,865 50
1881. O. B. Green, 3,007½ feet, at \$5.30	15,941 34
	31,806 84

Brush revetment from Station 41, west:

1881. O. B. Green, 1,400 feet, at \$1.64	2,296 00
1881. O. B. Green, labor, protecting banks	75 25
	2,371 25

Repairs, damages by storms, &c., to docking:

1880. O. B. Green, repairing docking	203 37
1881. O. B. Green, repairing harbor front	812 46
	1,016 83

Overseeing and incidental expenses, chief engineer:

Salary of W. T. Casgrain, chief engineer, from May 5, 1872, to December 3, 1881	22,602 25
Pay-roll of assistants and employes from May 5, 1872, to December 31, 1881	8,451 26
Traveling, office, and incidental expenses chief engineer's office	4,533 73
Maps, tracings, and office furniture, engineer department	923 17
Total superintending and incidental expense	36,510 61
Total construction disbursement	342,762 99

* Of this item, 17,546 yards, the Green Bay Dredge and Pile-Driver Company received 15 cents per yard and O. B. Green received 5 cents per yard. (Paid in 1882.)

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General expense account, Chicago office:

Salaries, legal, traveling, and incidental expenses from May 1, 1872, to October 10, 1882 \$22,828 92

Land department account:

Salaries of land commissioner and assistant, traveling, office, and incidental expenses relating to the sale of land grant, from May, 1877, to July 31, 1882 17,756 02

Real estate account:

Payments to assistant timber clerks, for services and expenses, examination of lands for appraisal, investigating trespasses, &c., from May, 1872, to December 31, 1881 15,522 03

Organization account:

Paid Joseph Harris, December 12, 1872, for expenses from 1864 to 1872, prior to organization of company 4,110 00

Bond expense account:

Paid M. L. Scudder, jr., financial agent and trustee, expenses and services as financial agent and trustee for bondholders \$4,250 00
Paid Sinnott & Meyer, attorneys, New York, preparing first mortgage land grant bonds 1,511 55
Paid for lithographing and engraving bonds and maps, printing pamphlet, and advertising bonds for sale 797 70
6,559 25

First mortgage bond account:

Bonds paid and canceled April 24, 1877 8,000 00

Interest account:

Interest coupons on bonds from December, 1874, to April, 1877.
Interest on notes and accounts, collection of drafts, &c 12,974 32

Canal operating account expenses:

Salary of superintendent and assistant, pay-rolls of employes, repairs and dredging in canal, incidental expenses, superintendent, charter of tug for towing through canal from April 1 to September 1, 1882.. 8,542 30

United States light-house department:

Payments in connection with condemnation of land for site of light-house, Sturgeon Bay, including cost of site, attorney, and court fees 370 39

Advances on land contracts sold:

Advanced and paid under guarantee, past due payments on contracts sold, contracts in hands of land commissioner for collection, advances in excess of collections 393 27

Total disbursements to October 10, 1882 439,819 49

Cash statement.

Receipts as per statement 461,981 35
Disbursements as per statement 439,819 49

Balance on hand October, 1882 22,161 86

In the foregoing statement no interest has been charged on the money advanced by the stockholders in 1872 and 1873.

We will furnish, in a few days, a detailed statement of the interest account on the moneys advanced, from the date of such advances to the present time, at the current rates.

No charge has been made in the foregoing accounts for services rendered by the officers of the company having the work in charge since 1872, other than the chief engineer and land commissioner, except the sum of \$6,250 paid the treasurer and assistant secretary for a portion of the time.

Resources of Canal Company, October, 1882.

Completed canal, including right of way, from Lake Michigan to Sturgeon Bay:	
Cash on hand October 10, 1882.....	\$22, 161 86
Land grant:	
120 acres of land unsold, contracts for which were foreclosed and canceled on account of non-payment originally sold for	\$230 00
Collected on same.....	88 42
	<hr/> 141 58
Land contracts unsold:	
Payments on which are past due	176 00
Payments maturing in 1882 and 1883	471 99
Advances made under guarantee on contracts sold, collections not being made at maturity	393 27
	<hr/>
Total due from land grant.....	1, 182 84
Personal property:	
Including maps, tracings, instruments, and office furniture, in offices of land commissioner and engineer department, cash valuation nominal, say	150 00
	<hr/>
Available assets exclusive of canal	23, 494 70

We hereby certify that the foregoing statement is correct, to the best of our knowledge and belief.

JESSE SPALDING,
President.

WM. E. STRONG,
Treasurer and Assistant Secretary.

E.

STATEMENT IN DETAIL OF INTEREST PAID BY THE STURGEON BAY AND LAKE MICHIGAN SHIP CANAL AND HARBOR COMPANY FROM MAY 7, 1882, TO OCTOBER 10, 1882, AS APPEARING IN STATEMENT OF RECEIPTS AND DISBURSEMENTS.

EXPLANATORY REMARKS.

* In order to carry on the work of construction and complete the first quarter of the canal, securing thereby the first quarter in value of the land grant, money had to be advanced beyond the loans made by the stockholders in 1872 and 1873, the company having no resources other than the lands.

The Peshtigo Company paid the bills for carrying on this work from September, 1873, till the spring of 1876. In May, 1876, Hon. William B. Ogden, president of the canal company, having been authorized by the board of directors, borrowed \$41,500 from the Third National Bank of New York, which sum was applied in payment of the company's indebtedness at that date. This loan was liquidated by the canal company in 1877 and 1878 by the first moneys realized from sales of land.

The interest on this loan from May 31, 1876, to August 22, 1878, amounting to \$4,452.88, was paid by the company.

Cash payments of interest by the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company from May 7, 1872, to October 10, 1882.

1873.	
Oct. 20. Paid stockholders in settlement of loan accounts, closing loan accounts after issue of stock.....	\$16 39
1875. Interest on note to Green, Fox & Howard, contractors:	
July 5. \$350.76, dated December 1, 1874, 6 $\frac{3}{4}$ months, at 7 per cent .	12 47
1876.	
July 31. \$514.19, dated December 1, 1874, 8 months, at 7 per cent ...	23 99
Feb'y 12. Interest on account, Henry Seibert & Bro., New York, lithographing and engraving bonds, maps, &c., \$721.50, 1 year 6 months, at 7 per cent.....	75 75

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1876.		
June 1.	*Interest on cash advances by the Peshtigo Company to William E. Strong, treasurer, carrying on work of the construction of canal from September 15, 1873, to June 1, 1876, represented by a disbursement of \$20,547.76.	
	Interest on disbursements from date of same to June 1, 1876, at simple interest, at 10 per cent	\$2, 735 89
	Interest on account with the Peshtigo Company for dredging, September and October, 1873, draining and clearing route of canal, May, June, and July, 1873, examining canal lands in 1874. Interest to June 1, 1876, at 10 per cent	1, 433 79
	Interest on account with F. B. Gardner, dredging, September, 1873. Interest to June 1, 1876, on \$2,360 94, at 10 per cent ..	629 47
	Interest on account with Sinnott & Meyers, attorneys, drawing mortgage bonds, &c., paid by W. B. Ogden December 31, 1875. Interest on \$1,511.55, from January 1, 1876, to June 1, 1876, at 10 per cent	62 98
	Interest on amount paid by W. B. Ogden, February 12, 1876, to Henry Seibert & Bro., lithographing, &c., \$721.50, and interest \$75.75 = \$797.25. Interest on this amount, \$797.25, from February 12, 1876, to June 1, 1876, 3½ months, at 10 per cent	23 92
	Interest on account with Charles D. Robinson, director, traveling expenses, \$210, May, 1872, to January, 1876. Interest to June 1, 1876, at 10 per cent	31 87
	Interest on account with Jesse Spalding, president, &c., traveling expense, &c.:	
	\$113.40 from May 1, 1874, to June 1, 1876, 2 years 1 month, at 10 per cent	44 46
	\$115 from January to September, 1874, to June 1, 1876, at 10 per cent	21 98
	\$246.85 from August, 1875, to June 1, 1876, at 10 per cent.	11 43
	Interest on account with Isaac Stephenson, director, traveling expenses, &c.:	
	\$190.50 from May 1, 1874, to June 1, 1876, 2 years 1 month, at 10 per cent	39 68
	\$134.20 from February 1, 1876, to June 1, 1876, 4 months, at 10 per cent	4 49
	\$157.60 from May, 1872, to March, 1875, to June 1, 1876, at 10 per cent	48 16
	3. Interest on note to Green, Fox & Howard, contractors:	
	\$107.05 from December 1, 1874, to June 1, 1876, 1 year 6 months, at 7 per cent	10 17
	*Interest on loan from Third National Bank of New York:	
Nov. 25.	\$41,500 from May 31, 1876, to November 25, 1876, 5 months 28 days, at 7 per cent	1, 436 37
1877.		
May 25.	\$41,500 from November 25, 1876, to May 25, 1877, 6 months 3 days, at 7 per cent	1, 464 43
1878.		
Aug. 22.	\$41,500 from May 25, 1877, to final payment of note, at 7 per cent	1, 552 08
1877.		
May 1.	Interest on note to M. L. Scudder, jr., financial agent and trustee, for services, \$4,000, from February 17, 1877, to May 1, 1877, 73 days, at 8 per cent	64 89
	Interest on notes to O. B. Green, contractor, given in payment on contracts:	
1878.		
Aug. 12.	\$1,353.24 from August 12, 1878, to November 13, 1878, 93 days, at 8 per cent	27 00
Dec. 14.	\$1,417.60 from September 13, 1878, to December 14, 1878, 93 days, at 8 per cent	29 30
1879.		
Jan. 11.	\$4,656.74 from October 11, 1878, to January 11, 1879, 93 days, at 8 per cent	96 24

1879.		
Mar. 15.	\$2,400 from January 11, 1879, to March 15, 1879, 63 days, at 9 per cent	\$37 80
June 16.	\$1,800 from March 15, 1879, to June 16, 1879, 93 days, at 9 per cent	41 96
Aug. 5.	\$3,000 from August 5, 1879, to November 6, 1879, 93 days, at 8 per cent	62 00
	\$2,742.82 from August 5, 1879, to December 6, 1879, 123 days, at 8 per cent	74 97
Paid bank collections and discounts on drafts, &c. :		
June 16.	Discount on 60-day draft, \$.25, from Schofield & Co.	7 55
Aug. 4.	Collection of check on Oconto bank	25
Oct. 21.	Collection of check on Milwaukee, \$748.63	74
	9. Interest to Green Bay Dredge and Pile-Driver Company, on past due payment on contract, \$1,195.66, 25 days, at 8 per cent ...	6 64
Interest paid on past due payments on land contracts:		
Aug. 14.	Sold A. H. Green, New York	25
Sept. 26.	Sold A. H. Green, New York	1 35
Oct. 31.	Sold A. H. Green, New York	65
Dec. 2.	Sold A. H. Green, New York	1 74
Dec. 15.	Sold A. H. Green, New York	11
1881. Paid bank collection of drafts and checks :		
May 23.	Collection of check on Milwaukee bank	1 09
July 25.	Collection of check on Green Bay bank	91
Sept. 30.	Collection of draft on New York, \$5,000	5 00
Dec. 23.	Collection of draft on New York, \$10,000	10 00
		10,151 26

Interest, coupons, discount, and gold premium on \$8,000 mortgage bonds issued to contractors in payment on contracts December 1, 1874, paid and canceled May 1, 1877.

1875.		
Jan. 1.	Discount on 8 bonds of \$1,000 each, taken at 90 cents, or 10 per cent. discount, by O. B. Green, Fox & Howard, contractors..	\$800 00
	Interest on \$8,000, from December 1, 1874, to February 1, 1875, date of coupons detached 2 months, at 7 per cent., \$93.33; premium in gold, 10 per cent., 9.33	102 66
	Payment of coupons No. 3 on the 8 bonds, 6 months' interest, at 7 per cent., due August 1, 1875 (February 1 to August 1)	280 00
	Paid coupon No. 4, due February 1, 1876, 6 months' interest, at 7 per cent	280 00
	Paid coupon No. 5, due August 1, 1876, 6 months' interest, at 7 per cent	280 00
	Paid coupon No. 6, due February 1, 1877, 6 months' interest, at 7 per cent	280 00
	Premiums on gold payments being made in currency	113 47
	Accrued interest on coupons not paid at maturity	26 93
	Accrued interest on bonds from February 1, 1877, date of last coupon paid, to May 1, 1877, date of payment of bonds, \$8,000, 4 months, at 7 per cent	140 00
	Premium on gold-paying \$8,000 gold bonds May 1, 1877, principal and interest being payable in gold	520 00
Total interest paid in cash		12,974 32

We hereby certify that the foregoing statement is correct, to the best of our knowledge and belief.

JESSE SPALDING,
President.

WM. E. STRONG,
Assistant Secretary and Treasurer.

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F.

STATEMENT OF THE TOTAL COST OF THE STURGEON BAY AND LAKE MICHIGAN SHIP CANAL, INCLUDING INTEREST ON ADVANCES MADE BY THE STOCKHOLDERS, AND EXPENSES INCURRED IN MANAGING THE CANAL TO DECEMBER 1, 1882.

CHICAGO, November 8, 1882.

GENTLEMEN: In answer to your letter of October 23, asking for a statement of the total cost of the canal, the total receipts realized from the lands, and the amount which the company would expect to receive in case the Government should decide to take the contract of the work, I wish to say—

The total cost of the Sturgeon Bay Canal, including interest on advances made by the stockholders to December 1, 1882, and expenses incurred in managing canal to October 10, 1882, is.....	\$642,615 57
Actual disbursement from October 10, 1882, to November 8, 1882, vouchers of superintendent for months of September and October	\$3,779 77
Land commissioner's office: salary and expenses of land commissioner to October 31, 1882.....	453 16
	<hr/> 4,232 93

Estimated expenses of managing canal and land department from date of unpaid services to December 1, 1882:

Canal-operating account:

Charter of tug, November	1,500 00
Salary of superintendent, November	150 00
Salary of assistants, November	95 50
Incidental expenses, November	35 00
Dredging 1,550 yards.....	225 00

Total operating canal.....	2,005 50
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Land commissioner's office:

Salary and expenses of land commissioner, November 1 to December 1, 1882.....	150 00
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	<hr/> 2,155 50
	649,004 00

Receipts from every source from May 7, 1872, to October 10, 1882, have been as follows:

Realized from the land grant of 200,000 acres	377,965 22
From original subscriptions to capital stock	2,665 00
From sale of bonds.....	8,000 00
Receipts from canal season of 1882 to October 10	14,016 76
From miscellaneous sources	351 03
From loans by stockholders in 1872 and 1873	58,983 34

	<hr/> 461,981 35
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Receipts from October 10, 1882, to November 8, 1882:

From canal tolls	2,775 38
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From land grant:

Collections on land contracts in October	273 78
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From past due contracts:

Advances, collections by the land commissioner	348 66
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Estimated receipts from November 8 to December 1:

Canal tolls and towing to close of season of navigation, 1882.....	5,000 00
Face valuation of unsold contracts on hand.....	456 25

	<hr/> 470,835 42
	178,168 58

If the Government should decide to take control of the work the canal company would expect to receive December 1, 1882, the sum of \$178,168.58.

Yours, very truly,

JESSE SPALDING,
President.

Col. D. C. HOUSTON and Maj. HENRY M. ROBERT,
United States Engineers.

G.

LETTER OF THE PRESIDENT OF THE STURGEON BAY AND LAKE MICHIGAN SHIP CANAL
AND HARBOR COMPANY EXPLANATORY OF STATEMENT F.

STURGEON BAY AND LAKE MICHIGAN
SHIP CANAL AND HARBOR COMPANY,
Chicago, November 18, 1882.

DEAR SIR: In answer to your letter of the 16th instant, I wish to say that the items you ask for, making up the balance of \$642,615.57, the cost of the canal to December 1, 1882, are as follows, viz:

Cash advances made by stockholders in 1872 and 1873, with interest to December 1, 1882, as per schedule herewith forwarded.....	\$140,383 58
The par value of 456 shares (\$45,600) of full paid stock, 450 shares of which (\$45,000) were issued September 9, 1872, to the officers and directors, by a vote of the board, for services rendered and expenses incurred prior to that date	45,600 00
To the officers and directors	\$45,000 00
To the chief engineer, for services during the construction of the canal	300 00
To the chief engineer, paid for in cash	100 00
To Joseph Harris, paid for in cash	100 00
To C. D. Robinson, paid for in cash	100 00
	45 600 00
A fair and reasonable compensation for the services rendered by the president, treasurer and assistant secretary, and book-keeper, from September 9, 1872, to December 9, 1882, a period of ten years and three months:	
To the president, \$1,000 a year	\$10,250 00
To the treasurer and assistant secretary, \$1,000 a year, less \$6,250 paid	4,000 00
To the book-keeper, \$250 a year	2,562 50
	16,812 50
Total	202,796 08
Yours, very truly,	

JESSE SPALDING,
President.

Col. D. C. HOUSTON,
United States Engineer, &c.

H.

STATEMENT IN DETAIL OF CASH ADVANCES BY STOCKHOLDERS IN 1872 AND 1873 TO
THE STURGEON BAY AND LAKE MICHIGAN SHIP CANAL AND HARBOR COMPANY. AS
APPEARING IN STATEMENTS F AND G.

Cash advances by stockholders of the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company, with interest on same to December 1, 1882.

Advanced by the Peshtigo Company, Chicago, Ill.

Subscription to capital stock:

1872.

May 8. Cash assessment of 5 per cent. paid on 200 shares of capital stock. \$1,000 00

Cash loan of \$26,785.69:

1872.

Oct. 7. Payment to William E. Strong, treasurer..... \$2,383 26

Nov. 9. Payment to William E. Strong, treasurer..... 8,960 55

Dec. 7. Payment to William E. Strong, treasurer..... 8,741 60

1873.

Mar. 18. Payment to William E. Strong, treasurer..... 665 34

Aug. 13. Payment to William E. Strong, treasurer..... 3,078 63

Sept. 10. Payment to William E. Strong, treasurer..... 2,956 31

Total loan

26,785 00

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Examination of canal lands on the Peshtigo River:

1872.		
Aug. 1. Labor, July, 27 days	\$69 18	
Sept. 1. Labor, August, 229 days	607 12	
Oct. 1. Labor, September, 155 days	395 30	
Nov. 1. Labor, October, 32½ days	116 07	
Dec. 1. Labor, November, 56 days	192 12	
1873.		
Aug. 1. Examination of 20,000 acres canal lands in townships 32 and 33, range 19	450 00	
		\$1,829 79
Total cash advances as above		29,615 48
Interest on above advances to September 10, 1873:		
Interest on \$26,785.69, loan, from date of advance to Sep- tember 10, 1873, at 10 per cent	1,739 32	
Interest on \$1,829.79, examination lands, from dates given to September 10, 1873, at 10 per cent	136 82	
Total interest to September 10, 1873		1,876 14
Total		31,491 62
Less cash paid September 10, 1873		1 62
Balance principal and interest September 10, 1873		31,490 00
For this balance, \$31,490, the Peshtigo Company received September 12, 1873, 314⅞ shares of the capital stock of the canal company.		
September 10, 1873, cash advances and interest to date, as per preceding statement		31,490 00
Interest on same compounded annually to December 1, 1882:		
Interest on \$31,490 from September 10, 1873, to December 31, 1873, 3 months and 20 days, at 10 per cent	\$962 19	
Interest on \$32,452.19 for year 1874, 12 months, at 10 per cent	3,245 22	
Interest on \$35,697.41 for year 1875, 12 months, at 10 per cent	3,569 74	
Interest on \$39,267.15 for year 1876, 12 months, at 9 per cent	3,534 04	
Interest on \$42,801.19 for year 1877, 12 months, at 8 per cent	3,424 10	
Interest on \$46,225.29 for year 1878, 12 months, at 8 per cent	3,698 02	
Interest on \$49,923.31 for year 1879, 12 months, at 8 per cent	3,993 86	
Interest on \$53,917.17 for year 1880, 12 months, at 7 per cent	3,774 20	
Interest on \$57,694.37 for year 1881, 12 months, at 7 per cent	4,038 40	
Interest on \$61,729.77 from January 1, 1882, to December 1, 1882, 11 months, at 6 per cent	3,395 14	
Total interest to December 1, 1882		33,634 91
Total principal and interest		65,124 91

Advanced by Jesse Spalding, Chicago, Ill.

Subscription to capital stock:

1872.		
May 8. Cash assessment of 5 per cent. paid on 51 shares capital stock ..		\$255 00
Cash loan of \$10,732.55:		
1872.		
Oct. 7. Payment to William E. Strong, treasurer	\$955 40	
Nov. 9. Payment to William E. Strong, treasurer	3,592 11	
Dec. 7. Payment to William E. Strong, treasurer	3,504 34	

1873.		
Mar. 18.	Payment to William E. Strong, treasurer	\$266 72
Aug. 13.	Payment to William E. Strong, treasurer	1,231 45
Sept. 10.	Payment to William E. Strong, treasurer	1,182 53
Total cash loan		\$10,732 55
Examination of canal lands on the Menominee River:		
One-half of bill for labor and supplies July, August, September, October, and November, 1872		471 81
Total cash advances to September 10, 1873		11,459 36
Interest on above advances:		
Interest on loan of \$10,732.55 from date of advance to September 10, 1873, at 10 per cent.		\$697 24
Interest on \$471.81, examination of lands from dates to September 10, 1873, at 10 per cent.		40 07
Total interest to September 10, 1873		737 31
Total		12,196 67
Less cash paid September 10, 1873		6 67
Balance principal and interest September 10, 1873		12,190 00
For this balance Mr. Spalding received September 12, 1873, 121- $\frac{1}{10}$ shares of the capital stock of the company.		
September 10, 1873, cash advances and interest to date as per preceding statement		12,190 00
Interest on same compounded annually to December 1, 1882:		
Interest on \$12,190 from September 10, 1873, to December 31, 1873, 3 months, 20 days, at 10 per cent.		\$372 48
Interest on \$12,562.48 for year 1874, 12 months, at 10 per cent.		1,256 25
Interest on \$13,818.73 for year 1875, 12 months, at 10 per cent.		1,381 87
Interest on \$15,200.60 for year 1876, 12 months, at 9 per cent.		1,368 05
Interest on \$16,568.65 for year 1877, 12 months, at 8 per cent.		1,325 49
Interest on \$17,894.14 for year 1878, 12 months, at 8 per cent.		1,431 53
Interest on \$19,325.67 for year 1879, 12 months, at 8 per cent.		1,546 05
Interest on \$20,871.72 for year 1880, 12 months, at 7 per cent.		1,461 02
Interest on \$22,332.74 for year 1881, 12 months, at 7 per cent.		1,563 29
Interest on \$23,896.03 from January 1, 1882, to December 1, 1882, 11 months, at 6 per cent.		1,314 28
Total interest to December 1, 1882		13,020 31
Total principal and interest		25,210 31

Advanced by Isaac Stephenson, Marinette, Wis.

Subscription to capital stock:

1872.		
May 8.	Cash assessment of 5 per cent. paid on 51 shares capital stock of company	\$255 00
Cash loan of \$10,732.55:		
1872.		
Oct. 7.	Payment to William E. Strong, treasurer	\$955 40
Nov. 9.	Payment to William E. Strong, treasurer	3,592 11
Dec. 7.	Payment to William E. Strong, treasurer	3,504 34
1873.		
Mar. 18.	Payment to William E. Strong, treasurer	266 72
Aug. 13.	Payment to William E. Strong, treasurer	1,231 45
Sept. 10.	Payment to William E. Strong, treasurer	1,182 53
Total loan		10,732 55
Examination of canal land, Menominee River:		
One-half of bill for labor and supplies furnished July, August, September, October, and November, 1872		471 82
Total cash advances to September 10, 1873		11,459 37

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Interest on above advances:

Interest on cash loan \$10,732.55 to September 10, 1873, at 10 per cent	\$697 24
Interest on \$471.81, examining lands to September 10, 1873, at 10 per cent	40 06
Total interest to September 10, 1873	\$737 30
Total	12, 196 67
Less cash paid September 10, 1873	6 67
Balance principal and interest September 10, 1873	12, 190 00

For this balance, \$12,190, there was issued September 12, 1873, 121 $\frac{2}{10}$ shares of the capital stock of company.

September 10, 1873, cash advances and interest to date as per preceding statement

Interest on same compounded annually to December 1, 1882:

Interest on \$12,190 from September 10, 1873, to December 31, 1873, 3 months, 20 days, at 10 per cent	\$372 48
Interest on \$12,562.48 for year 1874, 12 months, at 10 per cent	1, 256 25
Interest on \$13,818.73 for year 1875, 12 months, at 10 per cent	1, 381 87
Interest on \$15,200.60 for year 1876, 12 months, at 9 per cent	1, 368 05
Interest on \$16,568.65 for year 1877, 12 months, at 8 per cent	1, 325 49
Interest on \$17,894.14 for year 1878, 12 months, at 8 per cent	1, 431 53
Interest on \$19,325.67 for year 1879, 12 months, at 8 per cent	1, 546 05
Interest on \$20,871.72 for year 1880, 12 months, at 7 per cent	1, 461 02
Interest on \$22,332.74 for year 1881, 12 months, at 7 per cent	1, 563 29
Interest on \$23,896.03 for year 1882, from January 1 to December 1, 11 months, at 6 per cent	1, 314 28

Total interest to December 1, 1882

Total principal and interest

Advanced by F. B. Gardner.

Subscription to capital stock:

1872.	
May 8. Cash assessment of 5 per cent. paid on 51 shares capital stock....	\$255 00
Cash loan of \$10,732.55:	
Oct. 7. Payment to William E. Strong, treasurer	\$955 40
Nov. 9. Payment to William E. Strong, treasurer	3, 593 11
Dec. 7. Payment to William E. Strong, treasurer	3, 504 34
1873.	
Mar. 18. Payment to William E. Strong, treasurer	266 72
Aug. 13. Payment to William E. Strong, treasurer	1, 231 45
Sept. 10. Payment to William E. Strong, treasurer	1, 182 53

Total

Examination of canal lands on Pensaukee River:

Labor and supplies furnished October and November, 1872

Total cash advances to September 10, 1873

Interest on above advances:

Interest on cash loan of \$10,732.55 from date to September 10, 1873, at 10 per cent	697 24
Interest on \$303.15, examination of land from dates to September 10, 1873, at 10 per cent	23 49
Total interest to September 10, 1873	720 73
Total	12, 011 43
Less cash paid September 10, 1873	1 43

Balance principal and interest September 10, 1873

This balance, \$12,010, was paid by issue September 12, 1873, of 120 $\frac{1}{10}$ shares of the capital stock of company.

This stock was sold and transferred December 11, 1875, to Mr. William B. Ogden.

Estate of William B. Ogden—Continuation of account F. B. Gardner.

September 10, 1873, cash advances by F. B. Gardner, with interest to date as per preceding statement:

Stock received in settlement purchased by Mr. William B. Ogden,	
December 11, 1875	\$12,010 00
Interest on same compounded annually to December 1, 1882:	
Interest on \$12,010 from September 10, 1873, to December 31, 1873, 3 months, 20 days, at 10 per cent	\$366 97
Interest on \$12,376.97 for year 1874, 12 months, at 10 per cent	1,237 70
Interest on \$13,614.67 for year 1875, 12 months, at 10 per cent	1,361 47
Interest on \$14,976.14 for year 1876, 12 months, at 9 per cent	1,347 85
Interest on \$16,323.99 for year 1877, 12 months, at 8 per cent	1,305 92
Interest on \$17,629.91 for year 1878, 12 months, at 8 per cent	1,410 39
Interest on \$19,040.30 for year 1879, 12 months, at 8 per cent	1,523 22
Interest on \$20,563.52 for year 1880, 12 months, at 7 per cent	1,439 45
Interest on \$22,002.97 for year 1881, 12 months, at 7 per cent	1,540 21
Interest on \$23,543.18 for year 1882, from January 1, 1882, to December 1, 1882, 11 months, at 6 per cent	1,294 87

Total interest to December 1, 1882..... 12,828 05

Total principal and interest 24,838 05

Summary of cash advances by stockholders, with interest to December 1, 1882, as per statements.

Due the Peshtigo Company.....	\$65,124 91
Due Jesse Spalding	25,210 31
Due Isaac Stephenson.....	25,210 31
Due estate of William B. Ogden.....	24,838 05
Total.....	140,383 58

We certify that the foregoing statement is true to the best of our knowledge and belief.

JESSE SPALDING,
President.
WILLIAM E. STRONG,
Treasurer.

I.

Statement showing transit of vessels through the Sturgeon Bay and Lake Michigan Ship Canal, during seasons of 1879, 1880, 1881, and 1882, to October 1.

Month of—	Season of 1879.		Season of 1880.		Season of 1881.		Season of 1882.	
	Vessels.	Tonnage.	Vessels.	Tonnage.	Vessels.	Tonnage.	Vessels.	Tonnage.
		<i>Tons.</i>		<i>Tons.</i>		<i>Tons.</i>		<i>Tons.</i>
March			12	1,870	15	3,253	16	2,525
April			27	3,777	108	25,605	154	44,172
May			32	4,907	251	60,070	286	75,927
June	3	51	32	4,907	251	60,070	443	108,243
July	13	182	81	16,251	283	74,756	385	99,967
August	(*)	(*)	103	22,410	190	67,794	440	107,934
September	22	4,213	95	21,157	192	46,743	482	106,434
October	62	13,647	104	23,931	251	66,995		
November	60	13,978	79	19,076	190	57,186		
Total	160	32,071	533	113,379	1,480	402,402	2,206	545,202

* None reported.

1678 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

SUMMARY.

Period.	Vessels.	Tons.
During season of 1879.....	160	32, 071
During season of 1880.....	533	112, 379
During season of 1881.....	1, 450	402, 402
During season of 1882.....	2, 206	545, 202
Total.....	4, 379	1, 093, 054

We hereby certify that the foregoing statement is correct to the best of our knowledge and belief.

JESSE SPALDING,
President.

WM. E. STRONG,
Treasurer and Assistant Secretary.

K.

STATEMENT SUPPLEMENTARY TO STATEMENT L.

LETTER OF MR. WILLIAM E. STRONG.

OFFICE OF THE PESHTIGO COMPANY,
MANUFACTURERS OF LUMBER, LATH, &C.,
Chicago, December 16, 1882.

DEAR SIR: The tonnage of vessels using the canal during the month of November, 1882, amounted to 96,000. The total tonnage using canal for the present season amounted to 741,921 tons, against 402,402 tons for 1881.

Yours very truly,

WILLIAM E. STRONG.

Col. D. C. HOUSTON,
United States Engineers.

LETTER OF THE PRESIDENT OF THE STURGEON BAY AND LAKE MICHIGAN SHIP CANAL AND HARBOR COMPANY.

CHICAGO, ILL., November 10, 1882.

GENTLEMEN: I have the honor to submit the following statement of the transit of vessels through the Sturgeon Bay and Lake Michigan Ship Canal during the year 1882, viz:

Period.	Number of vessels.	Tonnage.
For the month of October, 1882	440	100, 719
Total number and tonnage to November 1, 1882	2, 048	645, 921
Estimated number and tonnage for month of November, 1882.....	256	89, 000
Aggregate for 1882.....	2, 301	735, 921

I am, very respectfully,

JESSE SPALDING,
*President Sturgeon Bay and Lake Michigan
Ship Canal and Harbor Company.*

Col. D. C. HOUSTON and Maj. H. M. ROBERT,
United States Corps of Engineers.

E E 12.

IMPROVEMENT OF AHNEPEE HARBOR, WISCONSIN.

Estimated cost (see Report of the Chief of Engineers, 1876, III, pages 346-359).....	\$175, 000
Appropriated.....	125, 000

This improvement consists in the formation and protection of a channel connecting the deep water in the lake with the deep water in

the river, by the extension of piers from the shore-line to the 18-foot curve in Lake Michigan, and the removal of the limestone rock from the bed of the river near the mouth for a distance of about 750 feet, so as to give a channel through the river bed 100 feet wide and 12 feet deep at low water, to the deep water in the river above.

Expenditures have resulted in the construction of 975 linear feet of revetted pile-pier, 800 linear feet of crib-pier, the removal of 77,865 cubic yards of sand, and about 15,800 cubic yards, scow measurement, of rock. Of the foregoing 800 linear feet of crib-pier, 450 linear feet require about five courses of superstructure to bring that portion of the pier in process of construction to completion. A channel about 50 feet wide exists between the piers carrying 10 feet of water, and a channel through the rocky bed of the inner harbor from 75 to 100 feet wide with from 8 to 12 feet of water.

During the past fiscal year operations have consisted in crib construction and pier extension, drilling, blasting, and rock removal—all of which were carried on by hired labor, use of the United States dredge, and purchase of material in open market.

CRIB CONSTRUCTION AND PIER EXTENSION.

The work of crib construction was applied to twelve crib substructures, 50 feet long, 20 feet wide, ten of which were built twelve courses high, and the remaining two, eight courses high. The work of pier extension consisted in placing nine of the above-mentioned twelve cribs, six in extension of the south and three in extension of the north pier. The remaining three cribs were moored in the inner harbor, awaiting future appropriations.

Operations on crib construction and pier extension began June 21, 1882, and closed November 18, 1882, with the expenditures of available funds. The timber used in the construction of the cribs was obtained from the Government reservation on Sturgeon Bay, and was furnished under an agreement with Mr. G. O. Spear, whereby he was to cut, saw, and deliver at Ahnapee, Wis., all timber suitable for crib construction at the rate of \$8 per 1,000 feet, B. M., and credit the United States with the difference between the total log scale as determined by the United States agent, and the timber delivered, at the rate of \$1.20 per 1,000 feet, B. M.; with the further agreement that all timber delivered in excess of that required for the construction of the twelve crib substructures built in the season of 1882 was to be delivered at Ahnapee or Sturgeon Bay, and at any time within two years from August 12, 1882, at the option of the United States, to be either paid for by the United States at the rate of \$8 per 1,000 feet, B. M., or sold to Mr. Spear at the rate of \$2 per 1,000 feet, B. M. Under this agreement according to the log scale of the United States agent, 1,198,644 feet B. M., were cut, of which 806,172 feet, B. M., were delivered at Ahnapee, and 75,000 feet, B. M., stored in the mill yard at Sturgeon Bay, to be subsequently delivered at the harbor piers, or an aggregate of 881,172 feet, B. M.; for the difference between the log scale, 1,198,644 feet, B. M., and the 881,172 feet, B. M., of manufactured timber, the United States received a credit in settlement of \$1.20 per 1,000 feet, B. M.

During the season of 1882 there were used in the construction of the before mentioned cribs 440,000 feet, B. M., leaving a balance of 366,172 feet, B. M., on hand at Ahnapee; this can be used with considerable profit to the United States under future appropriations for pier extensions and building superstructure over the substructures already placed. If under subsequent appropriations for this harbor the United

1680 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

States elects to pay Mr. Spear for the balance, or 366,172 feet, B. M., it will require a payment of \$2,548.41.

The timber was rapidly disappearing from the reservation, through forest fires and depredations, and in a few years would have been of no value. The gain to the United States by utilizing this timber has been about \$10 per 1,000 feet, B. M., or an aggregate saving of about \$8,000.

The stone used for crib-filling was removed from the bed of the river by the United States dredge.

The cost of building ten complete cribs and two partial ones and sinking nine cribs was as follows:

440,000 feet, B. M., timber and plank, at \$8.....	\$3,520 00
30,100 pounds drift-bolts, at 3.6 cents.....	1,053 60
7,300 pounds screw-bolts, at 4½ cents.....	328 50
Repairs of dock and tools.....	105 78
Scaling, receiving, and handling timber.....	264 00
Framing and bolting timber.....	1,314 79
Sinking nine cribs, including 860 cords stone, hire of scows and tug.....	1,535 00
Total.....	8,151 67

The cost of building and sinking one crib, 50 by 20 by 12½ feet, was as follows:

39,216 feet, B. M., timber, at \$8 per M.....	\$313 73
Framing and bolting 3,218 linear feet, at 4.4 cents.....	141 59
2,610 pounds drift-bolts, at 3.6 cents.....	93 96
632 pounds screw-bolts, at 4½ cents.....	28 44
95 cords stone, at \$1.80.....	171 00
Tools and repairs.....	10 00
Total.....	758 72

The cost of a similar crib built and placed by contract without utilizing stone from the river bed or timber from the reservation would have been about \$1,600.

ROCK REMOVAL AND DREDGING.

The operations of rock removal consisted in drilling, blasting, and dredging by hired labor and use of the United States dredge.

Twenty-three thousand five hundred and eighty-seven cubic yards of sand and mud were removed from the channel between the piers and inner harbor, and about 4,820 cubic yards of rock, scow measurement, from the channel through the river bed; of this latter quantity about 860 cords, or 4,085 cubic yards were loaded, on scows and placed in the cribs for filling; the remainder was cast over on the side of the river channel. The operations of the United States dredge began August 18 and closed November 4.

Under the operations of drilling and blasting the following work was done:

Area drilled and blasted.....	square feet..	28,000
Holes drilled.....	number..	495
Holes drilled and blasted.....	do.....	444
Holes drilled and abandoned.....	do.....	51
Holes drilled and blasted, aggregate depth.....	feet..	3,520
Holes drilled and blasted, average depth.....	do.....	8
Average depth of bottom of hole below water surface.....	do.....	18
Average depth of bottom of hole below proposed bottom.....	do.....	5
Drills sharpened.....	number..	223
Average distance drilled to each sharpening.....	feet..	17
Gross time drilling was in operation reduced to time of one drill.....	hours..	680
Net time drilling was in operation reduced to time of one drill.....	do.....	313
Dynamite No. 1 used.....	pounds..	2,87
Dynamite No. 2 used.....	do.....	313

The cost of the rock removal during the season of 1882 was as follows :

Drilling and blasting	\$5,606 72
Dredging blasted rock	2,078 48
Total	7,685 20

This was applied to the removal of about 4,800 cubic yards, scow measurement, of rock. From this cost of drilling and blasting was \$1.17 per cubic yard, and dredging 43 cents per cubic yard, scow measurement, or an aggregate cost of \$1.60 per cubic yard.

Since the commencement of the present project for the removal of the rock there has been expended as follows :

Drilling and blasting	\$19,361 39
Dredging rock	7,345 02
	<hr/>
	26,706 41

Under this expenditure about 15,800 cubic yards, scow measurement, of rock have been removed, making the cost for drilling and blasting \$1.22 per cubic yard, and for dredging 47 cents per cubic yard, or an aggregate of \$1.69 per cubic yard. Owing to the existence of a horizontal seam in the rock, described in previous reports, the entire area to be drilled and blasted had to be worked over twice and sometimes three times.

The foregoing statements of cost cover all expenditures except the local and general superintendence.

In addition to the 860 cords of stone used at Ahnepee during the past season, obtained from the rock removed from the river bed, there have been about 1,500 cords used at the harbors of Sturgeon Bay, Two Rivers, and Manitowoc, at a saving to the appropriations of these harbors of about \$4,500.

During the present season no operations are contemplated, since available funds were entirely exhausted with the close of last season's work.

Continuation of pier extension and rock removal is the work contemplated during the fiscal year ending June 30, 1885.

The cribs sunk during the season of 1882 are but slightly above the surface of the water, thereby rendering the use of the harbor dangerous to vessels attempting to enter during storms; sufficient appropriations for the early completion of this part of the work are urgently needed.

Money statement.

July 1, 1882, amount available	\$5,271 75
Amount appropriated by act passed August 2, 1882	12,000 00
	<hr/>
	17,271 75
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	17,145 98
	<hr/>
July 1, 1883, amount available	125 77
	<hr/>
Amount (estimated) required for completion of existing project	50,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	50,000 00

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COMMERCIAL STATISTICS.

Name of harbor, Ahnepee, Wis.

Collection district, Milwaukee, Wis.

Nearest light-house, Sturgeon Bay Canal, Wisconsin.

Arrival and departure of vessels during the year ending December 31, 1882.

Description.	Arrivals.			Departures.		
	No.	Tonnage.	Crews.	No.	Tonnage.	Crews.
Steamers.....	176	77,500	2,640	176	77,500	2,640
Sailing vessels.....	330	41,250	1,650	330	41,250	1,650
Total.....	506	118,750	4,290	506	118,750	4,290

EXPORTS BY WATER FOR THE YEAR ENDING DECEMBER 31, 1882.

Bark.....	cords..	1,800	Merchandise, general.....	pounds..	40,000
Beef.....	pounds..	90,000	Oats.....	bushels..	3,000
Beer.....	barrels..	75	Pease.....	do.....	25,000
Butter.....	pounds..	45,000	Posts.....	number..	200,000
Doors, blinds, and sash.....	number..	275	Potatoes.....	bushels..	6,000
Eggs.....	dozen..	50,000	Rags.....	pounds..	30,000
Fish.....	packages..	300	Rye.....	bushels..	6,000
Flour.....	barrels..	200	Shingles.....	number..	400,000
Hardware.....	tons..	190	Ties, railroad.....	do.....	840,000
Hides.....	number..	2,000	Wheat and barley.....	bushels..	225,000
Leather.....	tons..	40	Wood.....	cords..	4,500
Live stock.....	number..	450	Wool.....	pounds..	2,500
Lumber.....	feet, B. M..	500,000			

IMPORTS BY WATER FOR THE YEAR ENDING DECEMBER 31, 1882.

Apples.....	barrels..	700	Live stock.....	number..	200
Beef.....	pounds..	25,000	Lumber.....	feet, B. M..	500,000
Beer.....	barrels..	250	Machinery.....	pounds..	550,000
Coal.....	tons..	200	Merchandise, general.....	do.....	5,000,000
Dry goods.....	do.....	350	Oil.....	barrels..	350
Feed.....	do.....	450	Plaster, land.....	tons..	125
Flour.....	barrels..	6,500	Pork-barrels.....	number..	325
Fruit.....	pounds..	20,000	Provisions.....	pounds..	150,000
Groceries.....	do.....	450,000	Salt.....	do.....	250,000
Hardware.....	tons..	385	Shingles.....	number..	300,000
Hides.....	number..	200	Whisky.....	barrels..	175
Leather.....	tons..	6			

The above information was obtained from Mr. M. T. Parker.

EE 13.

IMPROVEMENT OF KEWAUNEE HARBOR, WISCONSIN.

Estimated cost (see Report of the Chief of Engineers, 1881, page 2084).....	\$200,000 00
Appropriated by the United States.....	\$17,000 00
Appropriated by local authorities.....	9,042 72
	25,042 72

This improvement consists in the construction of two parallel piers, 200 feet apart, extending from the shore line to the 18-foot curve in Lake Michigan, with the dredging of a channel between the piers, and through the land separating the river from the lake, so as to afford a channel of entrance not less than 12 feet deep at low water connecting the deep water in the lake with the deep water in the river.

Expenditures have resulted in the construction of 625 linear feet of revetted pile-pier.

During the past fiscal year, under the contract with the Green Bay Dredge and Pile-Driver Company, dated June 1, 1881, the 275 linear feet of pile-pier reported as incomplete in Annual Report of 1882, have been completed, and 100 linear feet of revetted pile-pier have been built under a contract with Messrs. Hanson & Scove, dated September 16, 1882. The United States dredge, dump-scows, and tug were thoroughly repaired, and the cost thereof partially paid from the available funds of this harbor.

During the present season operations will consist in the completion of the existing contract with Messrs. Hanson & Scove, under which there yet remains to be built 400 linear feet of pile-pier.

Continuation of pier extension is the work contemplated during the fiscal year ending June 30, 1885.

Money statement.

July 1, 1882, amount available.....	\$2,870 27
Miscellaneous receipts.....	14 00
Amount appropriated by act passed August 2, 1882.....	12,000 00
	<hr/> 14,884 27
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$5,724 75
July 1, 1883, outstanding liabilities.....	178 32
	<hr/> 5,903 07
July 1, 1883, amount available	8,981 20
	<hr/>
Amount (estimated) required for completion of existing project.....	174,957 28
Amount that can be profitably expended in fiscal year ending June 30, 1885.	50,000 00

Abstract of proposals for furnishing labor and materials for the construction of 400 linear feet pile-pier at Kewaunee Harbor, Wisconsin, opened September 5, 1882, by Maj. Henry M. Robert, Corps of Engineers.

Materials and labor.	Quantities.	Names and addresses of bidders.					
		George R. Roberts, Albion, Wia.	Green's Dredging Company, Chi- cago, Ill.	Kuapp & Gillen, Racine, Wia.	Green Bay Dredge and Pile Driver Company, Green Bay, Wia.	Truman & Cooper, Manitowoc, Wia.	Hanson & Scove, Manitowoc, Wia.
Round piles, furnished and driven, linear feet.....	11,745	\$0 40	\$0 25	\$0 22½	\$0 20	\$0 20	0 18½
Round piles, driving only, linear feet.....	1,755	20	16	11½	10	12	09
White-oak timber, furnished, framed, &c., M feet, B. M.....	21,576	45 00	45 00	50 00	48 00	42 00	43 00
White oak timber, framing only, M feet, B. M.....	2,924	25 00	25 00	25 00	20 00	10 00	10 00
Pine sheet-piling, furnished and driven, M feet, B. M.....	60,000	40 00	27 00	36 50	40 00	30 00	30 00
Pine timber, 12 by 12 inches, fur- nished and placed, linear feet.....	800	30	30	37	29	25	26
Pine timber, 6 by 12 inches, fur- nished and placed, linear feet.....	1,200	20	20	18½	18	30	15
Pine plank, laid, M feet, B. M.....	4,000	30 00	25 00	23 00	20 00	15 00	18 00
Stone, furnished and placed, cords.....	375	4 80	8 00	5 25	5 75	6 00	6 00
Stone, placing only, cords.....	75	2 00	3 00	2 00	1 80	1 00	1 50
Iron screw-bolts and tie-rods, pounds.....	10,000	06	10	06½	06½	05	05½
Wrought-iron spikes, pounds.....	400	06	08	06	07	05	05
Total approximate value of bid.....		11,667 02	10,718 07	9,589 11	9,515 88	8,760 03	8,480 29

Contract awarded to Hanson & Scove, dated September 16, 1882; in progress.

1684 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

List of materials and labor used in the construction of 525 linear feet pile-pier at Kewaunee Harbor, Wisconsin, under contract dated June 1, 1881, with the Green Bay Dredge and Pile-Driver Company.

Materials and labor.	Quantities.	Prices.	Amount.
Pine timber 12 by 12 inches.....linear feet..	854	\$0 27	\$230 58
Pine timber 6 by 12 inches.....do.....	1,014	15	152 10
*Oak timber 10 by 12 and 6 by 12 inches.....M feet, B. M.....	30,214	22 17	669 64
Placing oak timber 10 by 12 and 6 by 12 inches.....do.....	30,214	20 00	604 28
Pine plank.....do.....	4,338	20 00	86 76
*Round piles.....number.....	639	1 76 28	1,126 43
Driving round piles.....linear feet.....	16,200	12	1,951 20
Sheet piling (pine).....M feet, B. M.....	43,721	36 00	1,573 96
Sheet piling (oak).....do.....	3,956	46 00	181 97
*Stone.....cords.....	407.3	3 25	1,223 73
Flacing stone.....do.....	407.3	1 80	733 14
Drift-bolts.....pounds.....	12,965	05½	712 62
Spikes.....do.....	751	05½	41 20
Total			9,287 00

* Furnished by the Kewaunee harbor commissioners.

Cost per linear foot, \$17.691.

COMMERCIAL STATISTICS.

Name of harbor, Kewaunee, Wis.
Collection district, Milwaukee, Wis.
Nearest light-house, Twin River Point.

Arrival and departure of vessels during the year ending December 31, 1882.

Description.	Arrivals.			Departures.		
	No.	Tonnage.	Crews.	No.	Tonnage.	Crews.
Steamers.....	260	124,800	5,720	260	124,800	5,720
Sailing vessels.....	125	15,625	750	125	15,625	750
Total	385	140,425	6,470	385	140,425	6,470

EXPORTS BY WATER FOR THE YEAR ENDING DECEMBER 31, 1882.

Bark.....cords..	3,000	Pease.....bushels..	20,000
Butter.....pounds..	100,000	Posts.....number..	15,000
Cheese.....do.....	20,000	Potatoes.....bushels..	2,000
Eggs.....dozen.....	9,000	Rags.....pounds..	26,000
Flour.....barrels..	10,000	Rye.....bushels..	6,000
Feed.....tons.....	50	Shingles.....number..	6,000,000
Hay.....do.....	250	Tallow.....pounds..	6,000
Hides.....number..	3,000	Ties, railroad.....number..	250,000
Lumber.....feet, B. M.....	3,000,000	Wheat.....bushels..	75,000
Merchandise, gen'l.....pounds..	40,000	Wood.....cords.....	600
Oats.....bushels..	15,000	Wool.....pounds..	10,000

IMPORTS BY WATER FOR THE YEAR ENDING DECEMBER 31, 1882.

Apples.....barrels..	500	Leather.....tons.....	10
Beer.....do.....	500	Machinery.....pounds..	2,500,000
Coal.....tons.....	25	Merchandise, general.....do.....	200,000
Corn.....bushels..	6,000	Oil.....barrels..	400
Dry goods.....tons..	400	Plaster, land.....tons..	65
Fruit.....pounds..	10,000	Pork-barrels.....number..	400
Groceries.....do.....	3,000,000	Provisions.....pounds..	100,000
Hardware.....tons..	250	Salt.....barrels..	1,000
Iron and steel.....pounds..	100,000		

The above information was obtained from Mr. V. Mashek and Messrs. Jos. Duval & Co.

E E 14.

IMPROVEMENT OF TWO RIVERS HARBOR, WISCONSIN.

Estimated cost (see Report of the Chief of Engineers, 1871, page 111)....	\$265,588 80
Appropriated	190,000 00

This improvement consists in the construction of two parallel piers about 250 feet apart, extending from the mouth of the river to the 18-foot curve in the lake with dredging between the piers, so as to afford a channel of entrance not less than 12 feet deep at low water, connecting the deep water in the lake with the deep water in the river. Expenditures have resulted in the construction of 2,018 linear feet of revetted pile pier, 1,500 linear feet of crib pier, and 180,542 cubic yards of dredging. Of the foregoing 1,500 linear feet of crib-pier, 500 linear feet in extension of the south pier requires two courses of superstructure, 100 linear feet about five courses, and 100 linear feet in extension of the north pier about five courses of superstructure to bring that portion of the crib-pier in process of construction to completion. The incomplete superstructure also requires to be filled with stone and covered with deck plank. A channel about 100 feet wide exists for a distance of 600 feet outward from the inner ends of the piers; from thence the channel narrows to a width of about 75 feet for a further distance of 600 feet; from thence to the outer ends of the piers the channel is about 200 feet in width. The foregoing widths of channel carry 10 feet depth at low water.

During the past fiscal year operations have consisted in pier extension by contract and dredging with the United States dredge and hired labor. Under a contract with Messrs. Truman & Cooper, dated September 16, 1882, partial superstructure was built over 500 linear feet of the south pier, and two crib substructures or 100 linear feet of pier extension added to the same pier, completing the above-named contract.

The United States dredge removed during the fiscal year 26,436 cubic yards of material; of this quantity 17,162 cubic yards were from the channel between the piers, and 9,274 cubic yards from the inner harbor.

The following extract in relation to dredging is from the annual report of the officer in charge for 1882:

During the past spring the channel became entirely obliterated by the leveling off going on over the area between the piers, and for a distance of 700 linear feet there was only 7 feet of water. In order to afford temporary relief to the commerce of the place, all available funds being exhausted, I accepted the offer of the city of Two Rivers, made through Mr. Henry Mann, to pay the running expenses of the United States dredge while employed upon this harbor, with the understanding that the United States incurred no obligation thereby, but that I should recommend that dredging be done by the Government, and at its convenience, within the inner end of the piers, where it would be most useful to navigation, at the rate of one yard for every 15 cents expended by the city of Two Rivers. Under this arrangement the United States dredge began work at Two Rivers on the 30th of May, 1882, and by the end of the fiscal year had taken out 20,594 cubic yards of material, of which 1,105 were from the inner end of the south pier and the remainder from the channel.

The work of dredging was continued under the foregoing arrangement until August 19, 1882, and removing from July 1 to the close of work for the season 26,436 cubic yards, or including the quantity dredged to June 30, 1882, 47,030 cubic yards. Under the foregoing arrangement the United States would have to remove to reimburse the city of Two Rivers an aggregate of 21,704 cubic yards from the harbor within the inner ends of the piers; of this last amount 11,214 cubic yards were removed during the season of 1882, leaving a balance of 10,490 cubic yards to be removed from the inner harbor during the season of 1883. The entire cost of dredging the above-mentioned 47,030 cubic yards was

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\$3,255.51, and was paid by the city of Two Rivers through Henry Mann, esq.

During the present season operations will consist in dredging by hired labor and the use of the United States dredges to the extent of available funds.

Continuation of pier extension and dredging is the work contemplated during the fiscal year ending June 30, 1885.

Money statement.

July 1, 1882, amount available.....	\$17 36
Amount appropriated by act passed August 2, 1882	15,000 00
	<hr/> 15,017 36
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	10,025 80
	<hr/> 4,991 56
July 1, 1883, amount available.....	
Amount (estimated) required for completion of existing project	75,588 80
Amount that can be profitably expended in fiscal year ending June 30, 1885.	50,000 00

Abstract of proposals for furnishing labor and materials for building and placing two crib substructures and twelve partial superstructures at Two Rivers Harbor, Wisconsin, opened September 5, 1882, by Maj. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Pine timber, 12 by 18 and 12 by 12 inches, framed, 11,500 linear feet.	Hemlock timber, 12 by 18 and 12 by 12 inches, framed, 4,200 linear feet.	Pine plank, 3-inch, 6,000 feet, B. M.	Iron drift-bolts, 1-inch, round, 15,000 pounds.	Iron screw-bolts, 1½-inch, round, 1,200 pounds.	Wrought-iron spikes, 7 inches long, 200 pounds.	Stone, 570 cords.	Total approximate value of bid.
		Per lin. Per lin. Per M.	Per foot.	Per foot.	Per pound.	Per pound.	Per pound.	Per cord.	
1	Green Bay Dredge and Pile-Driver Company, Green Bay, Wis.	\$0 36	\$0 31	\$25 00	\$0 04½	\$0 06½	\$0 06½	\$7 00	\$10,351 90
2	Hanson & Scove, Manitowoc, Wis.	30	25	20 00	03½	05	04½	7 50	9,529 50
3	Knapp & Gillen, Racine, Wis.	33	30	23 00	04	05½	05	6 25	9,434 80
4	Truman & Cooper, Manitowoc, Wis.	31	28	15 00	04	05	05	6 75	9,267 50

Contract awarded to Truman & Cooper, dated September 16, 1882; closed June 30, 1883.

List of materials and labor used at Two Rivers Harbor, Wisconsin, in construction of two crib substructures and 509 linear feet partial superstructure, under contract dated September 16, 1882, with Messrs. Truman & Cooper.

Articles.	500 linear feet partial superstructure.	Two crib substructures.	Prices.	Amount.
Pine timber 12 by 18 and 12 by 12 inches.....linear feet..	9,024	2,528	\$0 31	\$3,581 12
Hemlock timber 12 by 18 and 12 by 12 inches.....do ..		3,908	26	1,016 06
Pine plank.....M feet, B. M.	1,932	4,941	15 00	103 10
Drift bolts.....pounds..	9,420	5,268	04	587 52
Screw bolts.....do ..		1,268	05	63 40
Spikes.....do ..	220	210	05	21 50
Stone.....cords..	267 12	288 7	6 75	3,718 03
Total cost	\$5,017 28	\$4,073 47		9,090 75

COMMERCIAL STATISTICS.

Name of harbor, Two Rivers, Wisconsin.

Collection district, Milwaukee, Wis.

Nearest light-house, Twin River Point, Wis.

Arrival and departure of vessels during the year ending December 31, 1882.

Description.	Arrivals.			Departures.		
	No.	Tonnage.	Crews.	No.	Tonnage.	Crews.
Steamers.....	174	7,260	720	174	7,260	720
Sailing vessels.....	146	8,800	576	146	8,800	576
	320	16,060	1,296	320	16,060	1,296

EXPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Apples.....	barrels..	900	Potatoes.....	bushels..	3,200
Bark*.....	cords..	4,800	Rags.....	pounds..	2,200
Beans.....	bushels..	450	Rye.....	bushels..	12,000
Barley.....	do..	3,600	Shingles.....	number..	250,000
Beef.....	pounds..	5,600	Feed.....	tons..	300
Beer.....	barrels..	500	Furniture.....	pieces..	44,000
Bricks*.....	number..	700,000	Hardware.....	pounds..	16,500
Butter.....	pounds..	5,800	Hay*.....	tons..	750
Castings.....	do..	40,000	Hides*.....	number..	51,000
Chairs*.....	number..	160,000	Household goods.....	pounds..	160,000
Cheese.....	pounds..	30,000	Ice.....	tons..	5,000
Corn.....	bushels..	2,400	Iron, bar and sheet.....	pounds..	7,000
Doors, blinds and sash.....	number..	110,000	Do., hoop.....	do..	40,000
Eggs.....	dozen..	22,000	Laths.....	number..	300,000
Fish (salt).....	packages..	400	Lumber.....	feet, B. M..	800,000
Fish (fresh)*.....	pounds..	600,000	Leather.....	tons..	1,700
Flour.....	barrels..	11,000	Slabs.....	cords..	700
Barrels, flour*.....	number..	9,000	Stone.....	do..	100
Do., pork.....	do..	200	Tallow.....	pounds..	3,000
Do., oil.....	do..	2,000	Telegraph poles.....	number..	2,400
Barrels and kegs, whisky.....	do..	1,000	Ties, railroad.....	do..	1,500
Lime.....	barrels..	600	Tools, farming.....	do..	2,000
Live stock.....	number..	1,250	Wheat.....	bushels..	54,000
Machinery.....	pounds..	120,000	Whisky.....	barrels..	50
Do., harvesting.....	do..	60,000	Wood.....	cords..	800
Merchandise, general.....	tons..	8,400	Woodenware.....	dozen..	200,000
Oats.....	bushels..	2,600	Wool.....	pounds..	5,000
Oil.....	barrels..	50	Varnish.....	gallons..	5,000
Pease.....	bushels..	32,600	Wire, staples.....	pounds..	52,000
Posts.....	number..	400			

IMPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Apples*.....	barrels..	2,200	Logs*.....	feet, B. M..	8,600,000
Bark*.....	cords..	5,300	Lumber, hard-wood*.....	do..	2,800,000
Barley.....	bushels..	7,200	Do., pine*.....	do..	2,000,000
Beef.....	pounds..	360,000	Machinery.....	pounds..	260,000
Beer.....	barrels..	390	Malt.....	do..	70,000
Brick*.....	number..	1,300,000	Merchandise, general.....	tons..	1,800
Castings.....	pounds..	70,000	Oil.....	barrels..	3,400
Coal.....	tons..	1,300	Paints, dry.....	pounds..	260,000
Corn.....	bushels..	7,500	Do., in oil.....	do..	70,000
Dry goods.....	tons..	400	Plaster, land.....	tons..	300
Feed*.....	do..	560	Pork-barrels.....	number..	50
Flour*.....	barrels..	1,500	Provisions.....	pounds..	360,000
Fruit.....	pounds..	20,000	Rags.....	do..	600
Groceries.....	do..	1,500,000	Salt*.....	barrels..	2,200
Hardware.....	tons..	440	Shingles*.....	number..	4,500,000
Hay*.....	do..	1,200	Stone*.....	cords..	860
Hides*.....	number..	53,000	Wheat.....	bushels..	72,000
Iron and steel.....	pounds..	320,000	Whisky and liquors.....	barrels..	260
Leather.....	tons..	1,800	Wire.....	tons..	720
Lime.....	barrels..	1,300	Wood*.....	cords..	1,800
Live stock.....	number..	1,600			

The above information was obtained from Mann Brothers.

* Transported by water.

E E 15.

IMPROVEMENT OF MANITOWOC HARBOR, WISCONSIN.

Estimated cost (see Report of the Chief of Engineers, 1881, page 2094)... \$308,182 54
 Appropriated 253,820 00

This improvement consists in the construction of two parallel piers about 250 feet apart, extending from the mouth of the Manitowoc River to the 18.5-foot curve in the lake, with dredging between the piers so as to secure 18 feet depth at the entrance, gradually diminishing to 14 feet deep at the shore, connecting the deep water in the lake with the deep water in the river.

Expenditures have resulted in the construction of 3,370 linear feet of crib-pier and the removal by dredging of 156,877 cubic yards of material. A channel about 200 feet wide exists between the piers carrying 18 feet at the outer end, gradually reducing to 14 feet at the shore-line.

During the past fiscal year operations have consisted in dredging, both by contract and use of the United States dredge, and also the repair of the United States dredge, dump scows, and tug by hired labor.

Under a contract with the Green Bay Dredge and Pile-driver Company, dated September 16, 1882, 18,722 cubic yards of material were removed. The United States dredge also removed 19,770 cubic yards, making an aggregate for the fiscal year 38,492 cubic yards.

Upon the opening of navigation in 1882 it was found that dredging in the channel would be necessary before the deep-draught vessels could enter the harbor; there being no funds available for the work, the city of Manitowoc undertook the work of doing the necessary dredging, under the direction of the United States, with the understanding that while the United States incurred no obligation thereby, still the officer in charge would recommend that an equal number of cubic yards should be hereafter removed by the United States from such parts of the harbor within the shore-line as the municipal authorities of Manitowoc should elect; this being approved by the Chief of Engineers, there were dredged by the city of Manitowoc between May 22 and July 3, 1882, 8,949 cubic yards of material from the channel between the piers. During the fiscal year the 8,949 cubic yards above mentioned have been removed from the inner harbor at the expense of the United States, thereby repaying the city of Manitowoc for the work done in the channel between the piers.

Previous to the work of 1882 no dredging had been done at this harbor since 1869, and it seems highly probable that with the dredging already done in the seasons of 1882 and 1883 no further dredging will be required for several years.

No further operations are contemplated during the season of 1883.

Continuation of pier extension is the work contemplated during the fiscal year ending June 30, 1885.

Money statement.

July 1, 1882, amount available.....	\$30 33
Amount appropriated by act passed August 2, 1882	10,000 00
	<hr/> 10,030 33
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$7,473 03
July 1, 1883, outstanding liabilities	49 15
	<hr/> 7,522 18
July 1, 1883, amount available.....	2,508 15
	<hr/> 54,362 54
Amount (estimated) required for completion of existing project.....	54,362 54
Amount that can be profitably expended in fiscal year ending June 30, 1885.	54,362 54

Abstracts of proposals for dredging at Manitowoc Harbor, Wisconsin, opened September 5, 1882, by Maj. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidder.	Dredging.
		<i>Per cu. yd.</i>
1	Carkin, Stickney and Cram, East Saginaw, Mich.....	\$0 42
2	Knapp & Gillen, Racine, Wis.....	28
3	Harry Fox & Co., Chicago, Ill.....	27
4	Truman & Cooper, Manitowoc, Wis.....	25
5	Green's Dredging Company, Chicago, Ill.....	24
6	Christoph H. Starke, Milwaukee, Wis.....	24
7	Green Bay Dredge and Pile-Driver Company, Green Bay, Wis.....	22

Contract awarded to Green Bay Dredge and Pile-Driver Company, dated September 16, 1882; closed November 25, 1882.

COMMERCIAL STATISTICS.

Name of harbor, Manitowoc, Wis.
Collection district, Milwaukee, Wis.
Nearest light-house, Manitowoc, Wis.

Arrival and departure of vessels during the year ending December 31, 1882.

Description.	Arrivals.			Departures.		
	No.	Tonnage.	Crews.	No.	Tonnage.	Crews.
Steamers	724	367,626	19,184	720	366,721	19,168
Sailing vessels.....	460	51,483	2,050	471	51,960	2,182
Total	1,184	419,109	21,238	1,191	418,681	21,350

EXPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Broom-handles.....bundles..	1,500	Malt	pounds..	103,980
Brick.....number..	1,054,000	Oats	bushels..	47,180
Butter	pounds.. 185,000	Pease	do..	98,656
Cheese.....boxes..	3,000	Posts	number..	11,200
Clover seed.....pounds..	112,777	Potatoes	bushels..	14,781
Eggs.....dozen..	91,090	Rags	pounds..	189,300
Fish.....pounds..	1,015,800	Ship-knees	number..	1,000
Flour	barrels.. 34,356	Sundries	packages..	38,119
Feed.....pounds..	1,658,000	Ties, railroad.....	number..	52,700
Hay	tons.. 3,138	Wheat.....	bushels..	21,495

IMPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Boots and shoes	cases.. 1,118	Laths	number..	704,000
Coal	tons.. 9,753	Lumber.....	feet, B. M..	5,063,000
Dry goods	cases.. 1,973	Oil	barrels..	578
Fish.....pounds..	1,095,300	Salt	do..	4,854
Fruit.....packages..	3,650	Shingles.....	number..	9,001,000
Groceries.....do..	27,000	Slabs	cords..	4,104
Hardware	do.. 12,741	Sundries	packages..	13,448

Vessels built during the year ending December 31, 1882.

Schooners.....number..	4	Steam-barges.....number..	1
Scows	do... 2	Tugs	do... 2

Vessels rebuilt during the year ending December 31, 1882.

Schooners.....number..	4	Propellers.....number..	1
Scows	do... 1		

The above information was obtained from Mr. George B. Burnet, deputy collector of customs.

E E 16.

IMPROVEMENT OF SHEBOYGAN HARBOR, WISCONSIN.

Estimated cost, additional estimate (see Report of the Chief of Engineers, 1881, page 2098).....	\$150,000
Appropriated	55,000

This improvement consists in the construction of two piers about 275 feet apart at the outer ends, extending from the mouth of the Sheboygan River to the 20-foot curve in the lake, with dredging between the piers so as to secure a channel 18 feet deep at the entrance to the piers, gradually reducing to 14 feet deep at the shore-line, connecting the deep water in the lake with the deep water in the river.

Expenditures have resulted in the construction of 3,581 linear feet of pier extension and the removal of 125,251 cubic yards of material by dredging.

A channel exists of variable width carrying from 10 to 11 feet at low water. A bar exists in the vicinity of the outer entrance to the piers which reduces the available depth to about 10 feet; the dredging of late years has been applied to the formation of a narrow channel through this bar. The dredging is very temporary in its relief, and the minimum amount consistent with the demands of commerce has been done, since permanent relief can only be gained by a rapid extension of the piers. The open condition of the old crib-pier permits large quantities of sand to pass through the piers and into the channel; this sand carried by currents is finally deposited near the entrance in the form of bars. It is probable that the most efficient method of overcoming this difficulty will be to render the piers sand-tight by some method of revetment.

During the past fiscal year operations have consisted in pier extension by contract, dredging by use of the Sheboygan City dredge under hire to the United States, the construction of United States dredge No. 2, and two dump scows, and also the repairs of United States dredge No. 1, two dump scows and tug. Under the modified contract with W. T. Casgrain, esq., dated June 1, 1882, 250 linear feet of crib-pier and 24 linear feet of pile-pier were built, complete, with superstructure; 200 feet were in extension of the north pier, and the remainder in extension of the south pier. The work was completed October 7, 1882, and closed the contract of June 1, 1882. Under the contract of September 16, 1882, with the same party for the building of 250 linear feet of crib-pier, with superstructure complete, at the close of the fiscal year two crib substructures had been placed; 5,408 cubic yards of material have been dredged from the channel through the outer bar.

From the appropriation of August 2, 1882, \$9,000 were set aside to be used in connection with appropriations from other harbors for building a dredge, two dump scows, and the purchase of a tug. For the details of this work, see report on Port Washington Harbor for this fiscal year.

During the season of 1883 operations will consist in the completion of the existing contract for pier extension.

The unstable character of the lake bed, in the vicinity of the pier extension, led to the adoption in 1881 of a pile foundation for the cribs to be placed under the contract of 1882; for the cribs placed under the contract of June 1, 1882, the foundation consisted of sixteen piles for each crib, driven to refusal with a steam hammer and cut off at about 12 feet below low water; the cribs placed upon these foundations subsequently settled, and experiments developed the fact that piles driven to refusal with the steam hammer weighing about 1,800 pounds could be

driven from 10 to 12 feet farther under the blows of a drop hammer weighing 3,000 pounds and falling from 5 to 10 feet. The number of piles below the cribs to be sunk under the contract of September 16, 1882, were increased in number to twenty for each crib, and provided for the driving of the piles to perfect refusal. The piles under this contract are driven to a depth of from 38 to 40 feet below the surface of the water, the water averaging about 17 feet in depth. Experience has not yet demonstrated whether the increased number of piles will give a perfectly stable foundation.

Since the estimate of \$150,000 made for the revised project in 1881, the necessary change from pile to crib pier, and the unexpected scour in the vicinity of the pier extension (which latter demands largely increased quantities of stone for foundations and riprap) will probably require the above estimate to be increased by about one-third.

The commerce of this important harbor has been greatly embarrassed during late years by the formation of the bar previously described, and it is believed that no permanent amelioration can be obtained until the pier extension has been carried over the bar to the deep water beyond; consequently appropriations of sufficient amount should be made so as to permit the rapid extension of the piers.

During the fiscal year ending June 30, 1885, the contemplated work is pier extension and such dredging as may be required to maintain a channel of entrance through the outer bar.

Money statement.

Amount appropriated by act passed August 2, 1882	\$30,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$10,951 76
July 1, 1883, outstanding liabilities	4,416 63
	<hr/> 15,368 39
July 1, 1883, amount available	14,631 61
Amount (estimated) required for completion of existing project	95,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	90,000 00

Abstract of proposals for furnishing labor and materials for building and placing five crib substructures at Sheboygan Harbor, Wisconsin, opened September 5, 1882, by Maj. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Pine timber 12 by 18 and 12 by 12 inches, framed; 12,000 linear feet.	Hemlock timber 12 by 18 and 12 by 12 inches, framed; 10,500 linear feet.	Pine plank laid 15,000 feet, R. M.	Iron drift-bolts, 1-inch round; 18,000 pounds.	Iron screw-bolts, 1½-inches; round; 3,300 pounds.	Wrought-iron spikes, 7 inches long; 600 pounds.	Stone; 650 cords.	Piles furnished, driven and cut off; 80.	Total approximate value of bid.
		Pr. lin. ft.	Pr. lin. ft.	Pr. M.	Pr. lb.	Pr. lb.	Pr. lb.	Per cord.	Per pile.	
1	Knapp & Gillen, Racine, Wis.	\$0 36	\$0 33	\$20	\$0 04½	\$0 06	\$ 06	\$9 00	\$14	\$16,099
2	W. T. Casgrain, Milwaukee, Wis.	35	32	25	4½	6	6	9 00	14	15,949

Contract awarded to W. T. Casgrain, dated September 16, 1882; in progress.

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List of materials and labor used at Sheboygan Harbor, Wisconsin, in the construction of 131½ linear feet of pile pier and six crib substructures with superstructures, under contract dated June 1, 1881, and modifications, dated August 24, 1881, and February 10, 1882, with William T. Casgrain.

Articles.		Quantities.	Price.	Amount.
Pine timber 12 by 12 and 12 by 18 inches.....	linear feet.....	39,080	\$0 31	\$9,516 00
Oak timber.....	M feet, B. M.....	4,948	40 00	197 92
Pine plank.....	do.....	22,006	25 00	550 15
Round piles.....	linear feet.....	3,752	25	938 00
Square piles.....	do.....	3,511	28	983 08
Piles for foundation.....	number.....	96	10 00	960 00
Drift-bolts.....	pounds.....	25,648	04½	1,154 16
Screw-bolts.....	do.....	5,461	05½	300 26
Spikes.....	do.....	943	04½	42 44
Tie-rods.....	do.....	2,100	05½	115 50
Stone.....	cords.....	1,167.5	8 35	9,815 63
Total.....				24,673 93

COMMERCIAL STATISTICS.

Name of harbor, Sheboygan, Wis.
Collection district, Milwaukee, Wis.
Nearest light-house, Sheboygan, Wis.

Arrival and departure of vessels during the year ending December 31, 1882.

Description.	Arrivals.			Departures.		
	No.	Tonnage.	Crews.	No.	Tonnage.	Crews.
Steamers.....	651	467,494	15,850	651	467,494	15,850
Sailing vessels.....	437	37,559	1,580	436	35,924	1,624
Total.....	1,088	505,053	17,430	1,087	503,318	17,474

EXPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Barley*.....	bushels..	10,000	Leather*.....	tons..	1,500
Do.....	do.....	30,000	Do.....	do.....	1,500
Beans*.....	do.....	20,000	Lime*.....	barrels..	10,000
Do.....	do.....	20,000	Do.....	do.....	1,000
Beer*.....	barrels..	1,000	Limestone*.....	cords..	400
Do.....	do.....	2,000	Live stock*.....	number..	1,000
Brick*.....	number..	200,000	Do.....	do.....	1,000
Do.....	do.....	1,000,000	Lumber.....	feet, B. M..	5,000,000
Butter*.....	pounds..	130,000	Merchandise, general*.....	tons..	7,500
Do.....	do.....	20,000	Do.....	do.....	7,500
Castings*.....	tons..	1,000	Mineral water*.....	quarts..	120,000
Do.....	do.....	500	Do.....	do.....	30,000
Chairs*.....	number..	500,000	Oats*.....	bushels..	150,000
Do.....	do.....	500,000	Pease*.....	do.....	25,000
Cheese*.....	pounds..	2,000,000	Do.....	do.....	25,000
Do.....	do.....	6,000,000	Plaster, land.....	tons..	3,000
Coal*.....	tons..	1,000	Potatoes*.....	bushels..	5,000
Do.....	do.....	6,000	Do.....	do.....	25,000
Cooperage*.....	packages..	15,000	Salt*.....	barrels..	500
Do.....	do.....	15,000	Do.....	do.....	2,000
Eggs*.....	dozen..	600,000	Shingles.....	number..	2,000,000
Do.....	do.....	200,000	Stoneware*.....	gallons..	67,000
Fish*.....	pounds..	400,000	Do.....	do.....	33,000
Do.....	do.....	100,000	Wheat*.....	bushels..	20,000
Flour*.....	barrels..	5,000	Do.....	do.....	130,000
Furniture*.....	pieces..	12,000	Wool*.....	pounds..	50,000
Do.....	do.....	8,000	Do.....	do.....	50,000
Hay*.....	tons..	1,000			

* Transported by water.

IMPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Bark*	cords..	15,000	Hardware	tons..	100
Do	do...	10,000	Hides*	numbers..	150,000
Beer*	barrels..	1,000	Do	do...	150,000
Do	do...	1,000	Iron and steel*	tons..	3,000
Brick*	number..	50,000	Do	do...	1,000
Coal*	tons..	12,000	Laths*	number..	2,000,000
Do	do...	3,000	Lumber	feet, B. M..	40,000,000
Corn*	bushels..	5,000	Do	do...	2,000,000
Do	do...	5,000	Machinery*	pounds..	200,000
Dry goods	do...	1,000	Merchandise, general*	tons..	7,000
Do	tons..	200	Do	do...	7,000
Doors, blinds, and sash*	pieces..	10,000	Pickets*	number..	500,000
Do	do...	40,000	Posts*	do...	10,000
Feed*	tons..	200	Salt*	barrels..	10,000
Do	do...	300	Shingles	number..	5,000,000
Hardware	do...	500	Wood*	cords..	3,000

The above information was obtained from J. L. Mallory, deputy collector of customs, E. F. Ewer, William Elwell, and others.

E E 17.

IMPROVEMENT OF PORT WASHINGTON HARBOR, WISCONSIN.

Estimated cost (see Report of the Chief of Engineers, 1877, page 866)	\$181,527 17
Appropriated	154,500 00

This improvement consists in the construction of two parallel piers about 150 feet apart, extending from the shore line to the 14-foot curve in Lake Michigan, together with the formation of two interior basins having a depth of 12 feet; the basins to be connected with the deep water in the lake by a dredged channel having a depth of 12 feet at low water. Expenditures have resulted in the construction of 406 linear feet of pile revetment, 1,690 linear feet of crib pier, and dredging 226,000 cubic yards of material from the basins and the channel between the piers.

Of the foregoing 1,690 linear feet of crib pier, 600 linear feet require two courses of superstructure and 150 linear feet about five courses of superstructure to bring that portion of the work in progress to completion.

A channel about 75 feet wide exists between the piers, carrying 10 feet of water, and the two interior basins, with a combined area of five and three-fourths acres, have an available depth of from 8 to 12 feet at low water.

During the past fiscal year, under a contract with Messrs. Truman & Cooper, dated June 1, 1881, one crib was placed in extension of the south pier. Under a contract with the same parties, dated September 16, 1882, partial superstructure was built over fourteen crib substructure, nine in extension of the north pier and five in extension of the south pier. This contract was closed December 2, 1882, with the expenditure of available funds.

From the appropriation of August 2, 1882, the following amounts upon the authority of the Chief of Engineers were set aside from the several harbors named for the purpose of building a dredge and two dump-scows, and the purchase of a tug to act as tender to the United States dredges.

The amounts so set aside were as follows:

Oconto	\$6,000
Sturgeon Bay	7,000
Sheboygan	9,000
Port Washington	8,000

* Transported by water.

The construction of the dredge hull, with cabin and crane and fitting and placing of the parts and machinery, was undertaken under a contract with Messrs. Rand & Burger, of Manitowoc, Wis., for the sum of \$7,000. The construction of two dump-scoops by the same parties for \$3,200. The construction of the engines, boiler, machinery, and all parts thereto belonging, together with one extra dipper, under a contract with the Vulcan Iron Works, of Chicago, Ill., for the sum of \$10,135; the construction of a wrought-iron truss with the same parties for the sum of \$2,900. The steam-tug Dione was purchased from the Gagnon Brothers, of Two Rivers, Wis., for \$2,500.

In addition to the foregoing amounts, provision was made in the original estimate for superintendence, freight, and cartage on machinery and parts, extra work not provided for in original contract, and the necessary outfit for placing the dredge and tug in working condition.

The amounts paid under the several disbursements and contracts to June 30, 1883, were as follows:

Rand & Burger:	
Dredge hull, &c	\$4,593 75
Two dump-scoops	2,200 00
Vulcan Iron Works:	
Dredge machinery and dipper	8,107 99
Wrought-iron truss	2,900 00
Freight and cartage	214 27
Truman, Merriam & Co.:	
Covering for steam-pipes and boiler	213 50
Superintendence, travel, and labor	1,341 84
Gagnon Brothers:	
Tug	2,500 00
Aggregate	22,071 35

This aggregate was divided between the several harbors previously named, as follows:

Oconto	\$5,287 93
Sturgeon Bay	4,365 25
Sheboygan	6,887 55
Port Washington	5,530 32

The construction of the dredge was virtually completed on June 30, and after being tested she will begin work at Sturgeon Bay.

During the present season no operations are contemplated at Port Washington, since available funds are entirely exhausted. About 150 linear feet of the south pier has not yet received any part of its superstructure, and consequently the cribs are but slightly above the water surface. The incomplete condition of this part of the work leaves it liable to injury from storms, and renders the use of the harbor dangerous at times to entering vessels.

During the fiscal year ending June 30, 1885, pier extension and dredging are contemplated.

Money statement.

Miscellaneous receipts	\$20 00
Amount appropriated by act passed August 2, 1882	17,000 00
	17,020 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$14,467 37
July 1, 1883, outstanding liabilities	2,469 68
	16,937 05
July 1, 1883, amount available	82 95
Amount (estimated) required for completion of existing project	27,027 17
Amount that can be profitably expended in fiscal year ending June 30, 1885	27,027 17

Abstract of proposal for furnishing labor and materials for building seventeen partial superstructures at Port Washington Harbor, Wisconsin, opened by Maj. Henry M. Robert, Corps of Engineers, September 5, 1882.

No.	Names and addresses of bidders.	Pine timber 12 by 12 inches framed, 10,600 linear feet.	Pine plank laid; 10,000 feet B. M.	Iron drift-bolts 1 inch round; 9,000 pounds.	Iron screw-bolts 1½ inches round; 200 pounds.	Iron wrought spikes 7 inches long; 200 pounds.	Stone; 270 cords.	Total approximate value of bid.
1	Knapp & Gillen, Racine, Wis...	<i>Per lin. ft</i> \$0 34	<i>Per M.</i> \$30 16	<i>Per lb.</i> \$0 04	<i>Per lb.</i> \$0 06½	<i>Per lb.</i> \$0 06½	<i>Per cord.</i> \$7 00	\$3,180 00
2	Truman & Cooper, Manitowoc, Wis.	32	16	04	05	05	6 75	5,754 50

Contract awarded to Truman & Cooper, dated September 16, 1882; closed November 27, 1882.

List of materials and labor used at Port Washington Harbor, Wisconsin, in construction of five crib substructures, each 50 by 20 by 12½ feet, under contract, dated June 1, 1881, with Messrs. Truman & Cooper.

Articles.	Quantities	Price.	Amount.
Pine timber, 12 by 18 and 12 by 12 inches linear feet..	17,343	\$0 32	\$5,549 76
Pine plank M feet, B. M.	7,908	20 00	158 16
Drift-bolts pounds..	14,262	04	570 48
Screw-bolts do...	3,247	05	162 35
Spikes do...	326	05½	17 92
Stone cords..	561	6 75	3,786 75
Total			10,245 43

Cost of each substructure..... \$2,049 09
Cost of substructure per linear foot..... 40 58

List of materials and labor used at Port Washington Harbor, Wisconsin, in construction of fourteen partial superstructures, under contract, dated September 16, 1882, with Messrs. Truman & Cooper.

Articles.	Quantities.	Price.	Amount.
Pine timber, 12 by 12 inches linear feet..	11,377	\$0 32	\$3,640 64
Pine plank M feet, B. M.	4,956	16 00	79 30
Drift-bolts pounds..	13,282	04	531 28
Screw-bolts do...	13	05	65
Spikes do...	399	05	19 95
Stone cords..	255.18	6 75	1,722 47
Total			5,994 29

Cost of superstructure per linear foot \$8.563

1696 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

COMMERCIAL STATISTICS.

Name of harbor, Port Washington, Wis.
Collection district, Milwaukee, Wis.
Nearest light-house, Port Washington, Wis.

Arrival and departure of vessels during the year ending December 31, 1882.

Description.	Arrivals.			Departures.		
	No.	Tonnage.	Crews.	No.	Tonnage.	Crews.
Steamers and sailing vessels.....	438	66,000	4,730	438	66,000	4,730

EXPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Apples* barrels..	1,000	Malt bushels..	180,000
Beans bushels..	500	Oats* do ..	25,000
Beer barrels..	1,800	Oil barrels..	500
Brick* number..	290,000	Pease bushels..	2,000
Butter pounds..	144,300	Plows and cultivators.. number..	300
Castings tons..	1,620	Potatoes bushels..	25,000
Cheese pounds..	360,000	Rags pounds..	300
Corn bushels..	500	Rye bushels..	10,000
Eggs dozen..	84,000	Stone* cords..	1,920
Fish packages..	4,800	Tallow pounds..	75,000
Elour barrels..	10,200	Wheat bushels..	36,000
Hay* tons..	600	Do* do ..	72,000
Leather sides..	20,400	Wood* cords..	200
Lime barrels..	240,000	Wool pounds..	15,600
Machines, smut..... number..	150		

IMPORTS FOR THE YEAR ENDING DECEMBER 31, 1882.

Bark* cords..	1,200	Lime and cement barrels..	700
Barley bushels..	160,000	Lumber* feet, B. M ..	8,000,000
Beer barrels..	100	Machinery pounds..	1,000,000
Coal tons..	4,300	Merchandise, general .. do ..	980,000
Coke do ..	240	Oil barrels..	1,000
Dry goods..... do ..	75	Plaster, land* pounds..	900,000
Groceries pounds..	200	Pork-barrels number..	100
Hardware tons..	300	Provisions pounds..	500,000
Hides number..	10,000	Salt barrels..	3,000
Iron and steel..... pounds..	3,000,000	Shingles* number..	7,200,000
Leather tons..	20	Wheat bushels..	3,000

The above information was obtained from E. R. Blake.

E E 18.

DEPOSITS OF SAND, ETC., IN PORTAGE LAKE, MICHIGAN.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 16, 1883.

SIR: I have the honor to acknowledge the reference to this office, on the 13th instant, of the resolution of the House of Representatives of that date, requesting the Secretary of War "to report to this House all facts within his knowledge deposits by certain mining com-

* Transported by water.

panies of silt and sand in the waters of Portage Lake, Michigan, and whether in his judgment any legislation is necessary to regulate the same," and to return it with the accompanying copy of a report from Maj. H. M. Robert, Corps of Engineers, made November 10, 1882, at the request of the Hon. Jay A. Hubbell, which will, it is believed, afford the required information.

It appears that the water route existing across the southern end of Keweenaw Point, through which the commerce of the south shore of Lake Superior passes, saves in distance about 38 miles over the *outside* route, between Duluth and the Sault Ste. Marie, besides avoiding the dangers and difficulties of the open lake navigation. Of this route Portage Lake forms an important part, and any obstruction to its navigation works injury to the whole system, and should therefore be prevented by proper legislation.

Very respectfully, your obedient servant,

H. G. WRIGHT,
*Chief of Engineers,
Brig. and Bvt. Maj. Gen.*

Hon. ROBERT T. LINCOLN,
Secretary of War.

REPORT OF MAJOR HENRY M. ROBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., November 10, 1882.

SIR: I have the honor to return the letter of Hon. Jay A. Hubbell, M. C., to the honorable the Secretary of War, referred to me for report. Assistant Engineer L. Y. Schermerhorn was directed to proceed to Hancock and Houghton, Mich., and investigate the subject of the injury to navigation caused by the stamp-mills depositing their silt and sand in Portage Lake, to which Mr. Hubbell refers. Mr. Schermerhorn's very full report, with accompanying map, contains the desired information, and is forwarded herewith.

Portage Lake near Hancock has a natural width of about 1,200 feet with a depth usually of over 40 feet, except very near the shore. This width has been reduced between the Franklin and Columbia Mills to about 400 feet. The sand dump of the Franklin Mill extends into the channel 650 feet at the water's surface, besides the outer slope of the dump, which lies where the water was 40 feet deep.

The Pewabic Mill, a little to the west of the Franklin, has by its sand dump encroached upon the channel some 600 feet. Still farther westward on the opposite shore (the southern) the sand dump of the Atlantic Mill projects 500 feet from the shore line, and extends 1,000 feet along the shore.

These three mills have made the greatest encroachments upon the natural channel, the next in order, the Quincy, having commenced building a dock 400 feet outside the natural shore line, which will prevent their sand dump from extending farther into the channel. This mill has also scowed away a part of its dump, depositing it in the middle of the channel, where the water is very deep.

The four mills just mentioned have deposited in the water-way in front of their mills over 1,000,000 tons each of sand. Nearly the same amount has been already deposited by the Osceola Mill, which is a newer mill than the others and the next to the largest of the lot. These five mills

have already deposited in the water-way in front of their premises over 5,500,000 tons of sand (equal to about 3,500,000 cubic yards), the dumps extending into 40 feet of water.

All the other mills in the vicinity, five in number, have together dumped into the water-way about as much sand as the smallest amount dumped by any one of the above mentioned five mills, while their present combined capacity and annual deposit is much less than that of any one of the five large mills.

At present the mills at this point are annually depositing somewhere about a half million tons, or one-third of a million cubic yards, of sand in the water-way. The annual cost of removing this deposit to where it would be no injury would probably be about \$40,000 or \$50,000, or \$5 for each of the 9,000 tons of copper annually worked by these mills. This would add one-quarter of a cent per pound to the cost of the production of copper by these mills, if their dump-sand were hereafter removed at their expense.

In this report the amounts of sand deposited are given up to December 31, 1881.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. L. Y. SCHERMERHORN, ASSISTANT ENGINEER.

OCTOBER 16, 1882.

SIR: I have the honor of submitting the following report of an examination of Portage Lake in the vicinity of Hancock and Houghton, Mich.

The object of the examination was to determine the extent to which the stamp-sand from the adjacent mines was being deposited in Portage Lake, and also the effect upon navigation resulting from such deposition. A water route exists across the southern end of Keweenaw Point, permitting the commerce of the south shore of Lake Superior to move between Duluth and Sault Ste. Marie uninterrupted by Keweenaw Point, saving about 38 miles in distance and the dangers and difficulties of an outside passage. A large part of the American commerce of Lake Superior passes over this route. Portage Lake is an important link in this water connection, and whatever jeopardizes the navigation of Portage Lake is of serious effect upon the commerce of Lake Superior. That part of Portage Lake which is under consideration originally had a width of from 1,200 to 1,500 feet, with a channel depth of over 40 feet, and a depth close to the shore of over 25 feet.

In the vicinity of Hancock and Houghton are located a number of copper mines. From these mines the copper-bearing rock is transported to stamp mills placed immediately on the shore of Portage Lake. Here the rock passes through breakers and stamps, reducing the rock to fine sand, from which the copper is removed by washers, and the refuse sand, mixed with water, is discharged from the mills into sluices which convey the sand into the adjacent lake. From 20 to 40 pounds of copper are obtained from a ton of rock; hence about 98 per cent. of the rock is discharged from the mills in the form of stamp-sand. The following statement of the quantity of rock stamped is only approximate, but is believed to be sufficiently exact for the object under consideration. The accompanying sketch of Portage Lake in the vicinity of Hancock and Houghton shows the location of the stamp mills and approximately the superficial extent of the sand deposits and their encroachments on the channel. The soundings are taken from the chart of the lake survey made in 1863, and are only intended to show the past condition of Portage Lake; no soundings were taken at the present examination.

FRANKLIN MINING COMPANY.

The stamp mill of this company was built about 1860, and has been in active operation about nineteen years. During this time it has stamped about 150 tons of rock per day for fifteen years, and 400 tons per day for four years. Its present capacity is about 300 tons per day. Upon these data the total quantity of rock stamped and dis-

charged in Portage Lake has been about 1,155,000 tons. The sand dump above the water surface extends into the lake about 650 feet beyond the original shore line, and is about 400 feet wide, and at its highest point attains an elevation of 20 feet above the surface of the lake. The outer end of the dump has filled the lake to a depth of about 40 feet. The lake was originally about 1,200 feet in width in the vicinity of this mill. By the extension of the sand dump on one side and docks on the other the width of the lake has been reduced to about 400 feet. Further encroachment will seriously threaten the navigation of Portage Lake.

FEWABIC MINING COMPANY.

The stamp mill of this company was built in 1858, and has stamped about as follows: 150 tons of rock per day for twenty years; 100 tons of rock per day for two years; 200 tons of rock per day for two years. Its present capacity is about 300 tons per day.

The aggregate quantity of rock stamped and discharged into Portage Lake has been about 1,080,000 tons. The dump extends into the lake about 600 feet beyond the original shore line, and attains an elevation at its highest point of about 15 feet above the surface of the lake. The outer end of the deposit has filled the lake to a depth of about 40 feet.

QUINCY MINING COMPANY.

The stamp mill was built in 1859 and began operations in 1861. The present yearly capacity of the mill is about 100,000 tons, or a daily capacity of 300 tons. To the close of the year 1881 the mill had stamped 1,284,000 tons of rock.

The sand dump extends into the lake about 350 feet, and along the shore easterly about 800 feet. This company are at present engaged in building a substantial dock about 400 feet from and parallel to the shore, and extending east about 800 feet, or to the highway bridge crossing the lake. The object of the dock is to furnish shipping facilities, and at the same time prevent an undue encroachment of stamp-sand deposit upon the adjacent docks. This company have also for the past five years attempted to discharge the stamp-sand into dump scows, and by this means remove the obstructions which obtain against its deposition in the vicinity of the mill.

The Quincy Mining Company seems thus far to have been the only one which has made any effort to prevent injury to navigation by a care for its stamp sand.

HANCOCK MINING COMPANY.

The stamp mill of this company has been running irregularly since its construction. The aggregate quantity of rock stamped has been about 112,000 tons. The present capacity of the stamps is about 125 tons per day, or 37,500 per year. The sand dump of this mill extends less than 200 feet into the lake, and compared with others is quite insignificant.

OSCEOLA MINING COMPANY.

The mill of this company was built in 1867, and has probably stamped about 850,000 tons of rock. The present capacity of the mill is about 500 tons per day, or 150,000 tons per year. The sand dump extends about 250 feet into the lake, and is about 300 feet wide, reaching an elevation 10 feet above the surface of the lake.

ATLANTIC MINING COMPANY.

These stamp mills were erected in 1874, and have stamped an aggregate of about 1,215,000 tons of rock. The present capacity of the stamp is about 600 tons per day, or 180,000 tons per year. The sand dump extends about 500 feet into the lake, and 1,000 feet along its shores.

HURON MINING COMPANY.

Stamps erected in 1861, and estimated to have stamped about 300,000 tons of rock. The daily capacity of the mill is about 25 tons, or 7,500 per year. The sand dump projects about 75 feet beyond the original shore, and is quite insignificant in extent.

GRAND PORTAGE MINING COMPANY.

The stamp mill of this company has been running but a short time. The mill has a capacity of about 75 tons per day, or 22,500 per year when run to its full capacity.

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SHELDON COLUMBIA MINING COMPANY.

The stamp mill of this company was operated for four or five years, but now stands idle. The total amount of rock stamped was about 60,000 tons.

ISLE ROYAL MINING COMPANY.

The mill of this company was erected in 1853, and since that time the stamps have been in operation irregularly, stamping about 370,000 tons of rock. The mill has a capacity of about 20 tons per day, or 6,000 per year. The sand dump from this mill extends about 250 feet into the lake.

CALUMET AND HECLA MINING COMPANY.

Near the head of Torch Lake, which is an arm of Portage Lake, are located the stamp mills of this company. Torch Lake is entirely out of the line of the water route of which Portage Lake is a part. These mills have been in operation for thirteen years, and have probably stamped an aggregate of 2,700,000 tons of rock. They have a present capacity of about 800 tons per day, or 240,000 tons per year.

This is probably the largest and richest copper mine of the world; producing about 12,000 tons of copper each year, having a value of over \$4,300,000. The location of these mills is beyond the limits of this examination, and the locality was not visited. They are not included in the following summary.

RECAPITULATION.

Name.	Capacity in tons.		Total tons of rock stamped.	Cubic yards sand.	
	Daily.	Yearly.		Yearly capacity.	Aggregate stamped.
Franklin mill	300	90,000	1,155,000	56,250	721,875
Pewabic mill	300	90,000	1,080,000	56,250	673,000
Quincy mill	350	105,000	1,284,000	62,500	802,500
Hancock mill	125	37,500	112,000	23,437	70,000
Oscoda mill	500	150,000	850,000	93,750	531,250
Atlantic mill	600	180,000	1,215,000	102,500	760,000
Huron mill	25	7,500	300,000	4,687	187,500
Grand Portage mill	75	22,500	22,500	14,062	14,062
Sheldon Columbia mill			60,000		37,500
Isle Royal	20	6,000	370,000	3,750	231,313
Total	2,295	688,500	6,448,500	417,186	4,031,000

In the above recapitulation the stamp-sand has been assumed to weigh 120 pounds per cubic foot, or 1.6 tons per cubic yard. The first, second, and fourth columns of figures are based on the mills running at their full stamp capacity as at present arranged; in practice these quantities are probably not realized, since the mills are seldom run at full capacity.

The third and fifth columns give the estimated quantity of rock stamped previous to December 31, 1881. This is practically the same as the amount of the sand deposited in the waterway.

The effects resulting from the deposition of stamp-sand in the waters of Portage Lake are highly prejudicial to the local and general interests of navigation. It affects the local interests by obstructing the docks and wharfs of Hancock and Houghton, and the general interests by narrowing and obstructing the channel of Portage Lake. The local commerce of Hancock and Houghton is almost entirely merged in the interest of the copper mines, and a community of interests prevents local action from restraining or correcting the obstruction of their own docks. I was unable to discover that any municipal action had ever been taken by the villages of Hancock or Houghton towards the establishment of dock lines or ordinances regulating the depositions of stamp-sand along the shore adjacent to these villages.

* In attempting to provide a remedy for the evil which now exists, it must be accepted that the monetary interests of the mining companies are very large, and that economical operations require the location of the stamp mills on the shores of Portage Lake.

Two plans for the disposition of the stamp-sand present themselves, viz, limiting the flow and encroachment of the sand by a comprehensive system of bulkhead or

dock lines, or the running of the stamp-sand into dump scows, and discharging the material at points where no injury will result to the interests of navigation.

Limiting the deposition of the stamp-sand to areas behind bulkheads would often require the lateral movement of the sand to considerable distances from the stamp mills. From 40 to 45 pounds of water are required to wash and convey one pound of sand away from the mill in sluices, having a slope of from one-fourth to three-eighths of an inch to the foot, consequently the distance to which the sand can be transported by sluices is limited by the obtainable slope of the sluices.

The first plan will also require that constructions often be placed in water having a depth of over 30 feet, and built with sufficient stability to withstand the enormous thrust resulting from a filling behind constructions of so great a depth; necessarily such constructions will be expensive.

In relation to the removal of the stamp-sand by means of dump scows, assuming from previous quantities that at least 300,000 cubic yards of stamp-sand are yearly produced, it would require that at least 1,000 cubic yards per day should be scowed away. During the winter season this plan of removal would not be possible, and the accumulated sand of winter would have to be either conveyed behind bulkheads or removed by dredges and scows during the open season of the year. If the plan of removal by scows was adopted the dumping of the stamp-sand should be carried on under such regulations as would insure its deposition at such places as would not jeopardize the interests of navigation.

During the year 1881, the mines bordering Portage Lake produced 8,830 tons of copper, having a value of \$3,224,586. The present profits derived from the operations of these mines are probably small, and hence it follows that to compel the mines to incur large additional outlay in caring for the stamp-sand would practically amount to a prohibition of the mining industry of Hancock and Houghton.

Very respectfully, your obedient servant,

L. Y. SCHERMERHORN,
Assistant Engineer.

MAJ. HENRY M. ROBERT,
Corps of Engineers, U. S. A.

APPENDIX F F.

CONSTRUCTION OF HARBOR OF REFUGE, MILWAUKEE BAY—IMPROVEMENT OF HARBORS OF MILWAUKEE, RACINE, KENOSHA, AND WAUKEGAN, LAKE MICHIGAN—IMPROVEMENT OF FOX AND WISCONSIN RIVERS.

REPORT OF LIEUTENANT-COLONEL D. C. HOUSTON, CORPS OF ENGINEERS, BREVET COLONEL, U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|--|-------------------------------|
| 1. Harbor of refuge, Milwaukee Bay, Wisconsin. | 4. Kenosha Harbor, Wisconsin. |
| 2. Milwaukee Harbor, Wisconsin. | 5. Waukegan Harbor, Illinois. |
| 3. Racine Harbor, Wisconsin. | 6. Fox and Wisconsin rivers. |
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UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., July 14, 1883.

GENERAL: I have the honor to transmit herewith annual reports for the works in my charge for the fiscal year ending June 30, 1883.

I am, general, very respectfully, your obedient servant,
D. C. HOUSTON,
Lieutenant-Colonel of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

F F 1.

HARBOR OF REFUGE, MILWAUKEE BAY, WISCONSIN.

CONDITION OF THE WORK JUNE 30, 1883.

The accompanying report of Mr. W. H. Hearding, assistant engineer, gives the condition of the work and its progress during the fiscal year ending June 30, 1883.

The accompanying tracing shows the plan of this harbor, the work done, and that to be done. The north arm of the breakwater will be completed, except superstructure, about August 1, 1883, making a total length of 2,450 feet.

PROPOSED APPLICATION OF FUNDS AVAILABLE FOR EXPENDITURE DURING THE FISCAL YEAR ENDING JUNE 30, 1884.

The outer 150 feet will be raised to a height of 6 feet above water, and the rest of the work to 2 feet above water. This work will be done this season, and will exhaust the available funds.

1704 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

PROPOSED APPLICATION OF FUNDS ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1885.

These will be applied to the extension of the breakwater southward and to maintenance of piers and channel at mouth of Milwaukee River.

The nearest collection district is Milwaukee, Wis. The nearest port of entry is Milwaukee, Wis.

Amount of revenue collected at the nearest port of entry during the last fiscal year was \$192,272.53.

The general commerce of the lakes, as well as the local commerce, will be benefited by this harbor.

Money statement.

July 1, 1882, amount available	\$42, 759 80
Amount appropriated by act passed August 2, 1882	100, 000 00
	<hr/> 142, 759 90
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$49, 634 17
July 1, 1883, outstanding liabilities	2, 300 88
	<hr/> 52, 015 05
July 1, 1883, amount available	90, 744 85
	<hr/> Amount (estimated) required for completion of existing project
Amount that can be profitably expended in fiscal year ending June 30, 1885.	600, 000 00 300, 000 00

Abstract of proposals received and opened September 29, 1882, for improving Milwaukee Bay, Wisconsin, for harbor of refuge—(timber crib breakwater on stone foundation).

Names and residences of bidders.	Pine timber, 1,454,100 feet, B. M.	Pine planks (2-inch), 60,400 feet, B. M.	Iron drift-bolts, 150,415 pounds.	Iron screw bolts, nuts, and washers, 3,200 pounds.	Iron spikes (7-inch), 2,500 pounds.	Stone ballast, 6,056 cords.	Framing timber, including plating, sinking, and filling, cribs, 1,614,640 feet B. M.	Total cost of 1,000 feet of crib breakwater on stone foundation.
Christopher H. Starke, Milwaukee, Wis.	Per M. \$19 50	Per M. \$18 00	Per lb. \$0 04	Per lb. \$0 06	Per lb. \$0 06	Per cord. \$8 90	Per M. \$0 25	\$108, 721 78
W. T. Casgrain, Milwaukee, Wis.	20 00	20 00	4½	6	6	12 00	10 00	125, 221 47
J. W. Dennis, Buffalo, N. Y. . .	20 00	19 00	5	8	6	9 00	10 00	107, 822 27

Contract made October 11, 1882, with Christopher H. Starke for the work, at prices given in his proposal above.

REPORT OF MR. W. H. HEARDING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Milwaukee, June 30, 1883.

SIR: I have the honor to submit the following report upon the harbor of refuge, Milwaukee Bay, Wisconsin. At the date of report, June 30, 1882, 200 feet of the substructure of breakwater remained to be built under the conditions of the contract of Joseph W. Dennis, of Buffalo, N. Y., of date June 20, 1881.

Four cribs, Nos. 23, 24, 25, and 26, each of dimensions 50 by 24 by 24½ feet, were sunk in the following month upon the lake bed, filled with stone ballast, and decked over with 3-inch pine plank. The sinking of these cribs completed his contract of 1,600 running feet of the substructure of the breakwater.



By act of Congress passed August 2, 1882, the sum of \$100,000 was appropriated for this work, and on the 11th of October a contract was made with Mr. Christopher H. Starke, of Milwaukee, Wis., for the construction of 1,000 running feet more or less of crib substructure, to be built and sunk in place upon a foundation of stone, the top of which to be leveled off at a depth of 20 feet below the water surface, and to be 16 feet wider than the cribs, the berme on the lake side to be 10 feet wide on top and on the land side to be 6 feet wide. The outer slope of foundation for a thickness of about 3 feet to be of stone, weighing not less than one ton each, the whole work to be completed on or before November 1, 1883. Cribs Nos. 27 and 28 were built and sunk in 1882, and five more cribs were built to a height of 18 courses each. A large quantity of stone was quarried and delivered upon the river bank during the winter, and the first crib of the season of 1883 was sunk on the 17th day of May. Previous to the sinking of this crib, I re-established instrumentally the point of my former survey, which governs the direction of the breakwater, and tested its alignment. I found that some of the cribs had settled slightly, the settlement being sufficient to throw the former range points somewhat out of line. I then established new points upon the cribs by boring holes into the timbers with an auger, into which rods are placed, which govern the setting of each crib in position. Cribs Nos. 29, 30, and 31 were sunk in place in May, and during the present month of June cribs Nos. 32, 33, 34, 35, 36, and 37 have been sunk, making a length of breakwater extension of 550 feet under the contract of Christopher H. Starke.

The total length of the substructure of breakwater at the present date is 2,150 feet.

The alignment and position of the cribs which have been sunk upon the stone foundation is excellent. Mr. Starke will complete the work under his contract and the substructure of the north arm of breakwater by building and sinking six more cribs, and by raising the superstructure of the cribs sunk in 1881 and 1882 (at such points as they have settled) to the height of 2 feet above datum.

The angle included between the lines of the north arm of breakwater and commencement of the arm running in a southerly direction will be formed by leaving off the inner horns of four cribs, and double dovetailing the inner corners. Two of these cribs will be built and sunk by Mr. Starke, which will form one-half the curve. The length of the substructure will then be 2,450 feet.

The three outer cribs will be built to a height of 6 feet above datum.

Respectfully submitted.

W. H. HEARDING,
Assistant Engineer.

Lieut. Col. D. C. HOUSTON,
Corps of Engineers, U. S. A.

F F 2.

IMPROVEMENT OF MILWAUKEE HARBOR, WISCONSIN.

CONDITION OF THE WORK JUNE 30, 1883.

The condition of the work and progress during the last fiscal year are given in the accompanying report of Mr. W. H. Hearing, assistant engineer.

PROPOSED APPLICATION OF FUNDS AVAILABLE FOR EXPENDITURE DURING FISCAL YEAR ENDING JUNE 30, 1884.

It is proposed to apply these funds to the maintenance of the channel of the river mouth.

I have estimated that an average annual expenditure of \$10,000 will probably be necessary for the maintenance of this harbor by pier-work and dredging. As this amount is irregular, some years much less being necessary, I have made no special estimate for this harbor for the fiscal year ending June 30, 1885, but would recommend that the appropriations for harbor of refuge, Milwaukee Bay, and Milwaukee Harbor, Wisconsin, be made under one head, so much of the same as may be necessary to be applied to maintaining the channel and works at the river mouth.

1706 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Money statement.

July 1, 1882, amount available	\$5, 107 95
Amount appropriated by act passed August 2, 1882.....	10, 000 00
	<hr/> 15, 107 95
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	979 32
July 1, 1883, amount available.....	<hr/> 14, 128 63

REPORT OF MR. W. H. HEARDING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Milwaukee, June 30, 1883.

SIR: I would respectfully state that no work has been done at the "Straight Cut" leading to this harbor during the past fiscal year, as a good navigable channel has been maintained between the harbor piers. No work is contemplated for the present season other than to make necessary repairs. On the 3d day of last month the steam barge Raleigh, of Cleveland, when entering, collided with the north pier at its eastern extremity, and damaged the same to a considerable extent, cutting through the pile protection and into the northeast pocket of the outer crib, crushing all of the oak fender timbers, the bulkhead, and the end timbers of the crib. The vessel was loaded with coal, and was drawing about 13 feet of water.

The heavy storm which prevailed on Lake Michigan from the 20th to the 23d ultimo carried away the protection piles which were fractured by the collision, and washed out about 10 cords of stone ballast from the northeast corner of the crib. The probable cost of repairing this break will approximate \$600. A thorough investigation was made of this occurrence with a view to determine whether the accident was unavoidable or the result of carelessness.

The obtainable evidence showed satisfactorily that the mishap was due to an extraordinary strong current which was setting out of the river at the time, and which rendered the vessel unmanageable.

Soundings were taken between the harbor piers on the 10th and 12th of April last, upon cross-sectional lines run at parallel distances of 50 feet, the distances between soundings on these lines being 25 feet. A plot of the same with depths of water reduced to mean lake level shows the channel, which carries over 17 feet of water, to be 130 feet in minimum width at its west end, and 260 feet in maximum width at its outer or east end.

The nearest collection district is Milwaukee, Wis. The nearest port of entry is Milwaukee, Wis.

The amount of revenue collected at this port during the fiscal year (customs) is reported by A. W. Hall, esq., collector, to have been \$192,272.53. He also furnishes the following information respecting the arrivals at and departures of vessels from this harbor.

Arrivals and departures.	Number.	Tonnage.
Arrivals of steamers.....	2, 503	2, 221, 508
Arrivals of sail-vessels.....	2, 876	456, 448
Total.....	<hr/> 5, 379	<hr/> 2, 677, 956
Departures of steamers.....	2, 648	2, 250, 282
Departures of sail-vessels.....	2, 891	444, 458
Total.....	<hr/> 5, 539	<hr/> 2, 694, 740

I have the honor to subscribe myself, very respectfully, your obedient servant,

W. H. HEARDING,
Assistant.

Lient. Col. D. C. HOUSTON,
Corps of Engineers, U. S. A.

F F 3.

IMPROVEMENT OF RACINE HARBOR, WISCONSIN.

CONDITION OF THE WORK JUNE 30, 1883.

The condition of the work and progress during the last fiscal year are given in the accompanying report of Mr. W. H. Hearing, assistant engineer.

PROPOSED APPLICATION OF FUNDS AVAILABLE FOR EXPENDITURE DURING THE FISCAL YEAR ENDING JUNE 30, 1884.

It is proposed to expend these funds in pier work and dredging.

PROPOSED APPLICATION OF FUNDS ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1885.

As has been stated in former reports, the principal difficulty at this harbor is due to the widening of the channel from 160 feet near the shoreline to 270 feet at the entrance, in a distance of about 1,000 feet. The effect of this funnel-shaped entrance is to increase the disturbance of seas entering the harbor, making it difficult for vessels to lie at the docks, and increasing, it is believed, the periodical shoaling between the piers. To remedy this difficulty it is proposed to extend the south pier to a point opposite the end of the north pier, leaving an opening between the present end of the south pier and the inner end of the extension, to be crossed by a pile-bridge, as shown on the accompanying plan. The extension will break the force of waves from the southeast which strike the north pier and are deflected up the channel, and the opening will permit waves from the northeast to pass through instead of being deflected up the channel, as would be the case were the south pier to be extended continuously. It will also serve to reduce the force of waves coming directly into the harbor. The length of this extension will be 350 feet, at an estimated cost of \$28,000.

There is estimated for this harbor the sum of \$35,000 for pier extension, dredging, and repairs.

The nearest collection district is Milwaukee, Wis. The nearest port of entry is Milwaukee, Wis.

Amount of revenue collected at the nearest port of entry during the last fiscal year was \$192,272.53.

Money statement.

July 1, 1882, amount available	\$1,133 18
Amount appropriated by act passed August 2, 1882.....	7,000 00
	<hr/>
	8,133 18
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	1,245 39
	<hr/>
July 1, 1883, amount available.....	6,887 79
	<hr/>
Amount (estimated) required for completion of existing project.....	35,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	35,000 00

1708 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

REPORT OF MR. W. H. HEARDING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Milwaukee, June 30, 1883.

SIR: The following report upon Racine Harbor, Wisconsin, is respectfully submitted:

The sum of \$7,000 was appropriated for this harbor by act of Congress, August 2, 1882. No work has been done at this harbor during the last fiscal year, with the exception of repairing the crib at the eastern extremity of the south pier, which was damaged by collision of the schooner Larinda in November, 1881. As the end timbers of the crib were broken and carried away to a depth of about 4 feet below the water surface, the repairs were made by driving oak piles, each 34 feet long, around the end of the crib, as close together as practicable, and securing the same to the sound timbers of the crib by means of wales and binders, screw-bolts, and tie-rods. This work was done by hired labor and appliances, and purchase of materials.

On the 25th ultimo I took soundings in the harbor channel, the plot of which shows that vessels drawing not more than 12½ feet of water can enter the harbor in favorable weather, the soundings being reduced to mean lake level.

Several vessels belonging to and trading at Racine are of a large class, and with full cargoes on board would draw a greater depth of water than exists in the channel, and as Racine is becoming a depot for the reception and distribution of large quantities of coal and other heavy commodities, the vessel owners and merchants interested are desirous of having the channel deepened by dredging.

To provide a channel at mid-distance between piers of 80 feet in width and 16 feet in depth will require the removal of about 18,000 cubic yards of material. I believe it to be your intention to provide such a channel as soon as practicable. In addition to this a few necessary repairs will be made to the north pier.

Racine is in the collection district of Milwaukee, Wis. The nearest port of entry is Milwaukee, Wis.

The amount of revenue collected at the nearest port of entry during the last fiscal year was \$192,272.53.

The arrivals and departures at this harbor during the past fiscal year, as per information furnished by A. W. Hall, esq., collector of the port, were as follows:

Arrivals and departures.	Number.	Tonnage.
Arrivals of steamers.....	581	314, 418
Arrivals of sail-vessels.....	698	96, 436
Total	1, 287	410, 853
Departures of steamers.....	581	314, 696
Departures of sail-vessels.....	693	96, 446
Total	1, 274	411, 046

I have the honor to subscribe myself, very respectfully, your obedient servant,
W. H. HEARDING,
Assistant.

Lieut. Col. D. C. HOUSTON,
Corps of Engineers, U. S. A.

F F 4.

IMPROVEMENT OF KENOSHA HARBOR, WISCONSIN.

CONDITION OF THE WORK JUNE 30, 1883.

The condition of the work and the progress during the last fiscal year are given in the accompanying report of Mr. W. H. Hearing, assistant engineer.

PROPOSED APPLICATION OF FUNDS AVAILABLE FOR EXPENDITURE
DURING THE FISCAL YEAR ENDING JUNE 30, 1884.

It is proposed to apply these funds to necessary repairs.

**PROPOSED APPLICATION OF FUNDS ASKED FOR THE FISCAL YEAR
ENDING JUNE 30, 1885.**

It is proposed to apply these funds to pier extension, repairs, and dredging.

The nearest collection district is Milwaukee, Wis. The nearest port of entry is Milwaukee, Wis.

Amount of revenue collected at the nearest port of entry during the last fiscal year was \$192,272.53.

Money statement.

July 1, 1882, amount available.....	\$878 93
Amount appropriated by act passed August 2, 1882.....	6,000 00
	<hr/> 6,878 93
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	4,537 68
	<hr/> 2,341 25
Amount (estimated) required for completion of existing project.....	51,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	16,000 00

**ABSTRACT OF PROPOSALS RECEIVED AND OPENED SEPTEMBER 29, FOR IMPROVING
HARBOR AT KENOSHA, WISCONSIN (SUPERSTRUCTURE, NORTH PIER).**

Names of bidders, Knapp & Gillen, Racine, Wis.

Pine timber, 129,768 feet, B. M., per M.....	\$19 75
Pine plank (3-inch), 3,000 feet, B. M., per M.....	16 50
Iron drift-bolts, 18,409 pounds, per pound.....	04
Iron spikes (7-inch), 300 pounds, per pound.....	06
Framing timber, 132,868 feet, B. M., per M.....	13 00

Bid of Knapp & Gillen only one received. Contract made with them October 16, 1882, for the work at prices given in their proposal above.

REPORT OF MR. W. H. HEARDING, ASSISTANT ENGINEER.

**UNITED STATES ENGINEER OFFICE,
Milwaukee, June 30, 1883.**

SIR: I have the honor to submit the following report of work done for the improvement of Kenosha Harbor, Wisconsin, during the past fiscal year:

By act of Congress of date August 2, 1882, the sum of \$6,000 was appropriated for this harbor. On the 16th day of October a contract was made with Messrs. Knapp & Gillen, of Racine, Wis., for building superstructure over the two cribs at the east end of the north pier, which were sunk in 1880 and 1881 respectively; also for removing 290 running feet of old superstructure of the north pier, in the vicinity of its intersection by the shore-line to the northward of the harbor, and reconstructing the same with new materials.

The superstructure over the cribs was built to the height of 6.3 feet above mean lake level, and a substantial bulkhead was bolted to the outer extremity of the pier, and both cribs were decked over with 3-inch pine planks well spiked on and battened. A section of the old superstructure of about 180 feet in length was 9 feet above mean lake level, which is the zero of measurement. On the north or outer side of a portion of this section the surface of the sand and gravel accretions was on a horizontal plane with the top of the upper timbers. The new timbers of the north wall were built up to a height of 7½ feet above datum where the shore line intersects the pier, but not for a sufficient length to prevent the material from being carried into the pier during storms, so that it will be necessary to bolt on a few more timbers for a length of 150 feet of the wall to effectually check its passage. About forty cords of surplus stone-ballast were taken from the high section and deposited in the outer cribs, which filled the outer pockets up to within 2 feet of the top of pier. In all the other pockets of these cribs the stone averages 2 feet in height above datum.

1710 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

A plat of the soundings which were taken at this harbor on the 26th day of last month shows a navigable channel of 11 feet in depth for the whole distance between piers, with the depths of water reduced to mean lake level.

The dredging machine, which belongs to the city of Kenosha, has been rebuilt during the past winter, and I believe it is the intention of the city authorities to dredge in the harbor and basin to a considerable extent. As soon as practicable sheet-piling will be driven, in accordance with your instructions, along the south face of a section of the south pier near its western extremity, covering the intersection of the shore-line to the southward of the channel, in compliance with the request of the harbor committee, who report that a large quantity of sand passes through the pier at that point, and which constantly necessitates the use of a dredging machine.

An estimate of the cost of doing this work, together with bolting necessary timbers on the north wall of the north pier, to arrest sand, is \$1,266.98.

Kenosha is situated in the collection district of Milwaukee, Wis. The nearest port of entry is Milwaukee, Wis.

By courtesy of A. W. Hall, esq., collector of the port of Milwaukee, the following information is given:

The amount of revenue collected at the nearest port of entry during the last fiscal year was \$192,272.53.

The arrivals at and departures of vessels from Kenosha during the past fiscal year were as follows:

Arrivals and departures.	Number.	Tonnage.
Arrivals of steamers.....	25	7,879
Arrivals of sail-vessels.....	224	22,019
Total.....	249	29,898
Departures of steamers.....	25	7,884
Departures of sail-vessels.....	208	21,739
Total.....	233	29,623

Respectfully submitted.

W. H. HEARDING,
Assistant Engineer.

Lieut. Col. D. C. HOUSTON,
Corps of Engineers, U. S. A.

FF 5.

IMPROVEMENT OF WAUKEGAN HARBOR, ILLINOIS.

CONDITION OF THE WORK JUNE 30, 1883.

The accompanying report of Mr. W. H. Hearing, assistant engineer, gives the condition of the work and the progress during the last fiscal year.

The accompanying plan shows the present condition of the work.

PROPOSED APPLICATION OF FUNDS AVAILABLE FOR EXPENDITURE DURING THE FISCAL YEAR ENDING JUNE 30, 1884.

The available funds will be exhausted the present season in extending the south pier.

PROPOSED APPLICATION OF FUNDS ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1885.

It is proposed to apply these funds to extending the piers and dredging a channel from the lake to the proposed inner harbor basin shown on the accompanying plan.

The limited appropriations which have been made for this harbor ren-

dered it necessary to change the original plan made in 1879. Prices have also advanced, and a revised estimate is submitted for completing the improvement according to the present plan, as follows :

Pier extension to depth of 12 feet.....	\$45,000
Docking sides of channel on Government land.....	5,500
Dredging.....	60,500
	<hr/> 111,000

It is expected that the property-owners will do the docking outside of the land conveyed to the United States.

As will be seen from the plan, the work on the harbor has not advanced sufficiently to be of any value to commerce. The statistics furnished by the harbor committee and published in the Annual Report of the Chief of Engineers for 1882, page 2165, refer to the business of the place, most of which, in the matter of transportation, is done by rail.

The objects sought to be accomplished by the construction of this harbor, and the desires of the citizens in reference to it, are given in the Annual Report of the Chief of Engineers for 1880, pages 1940 to 1947, which contain the report of the survey on which the project was based.

The nearest collection district is Chicago, Ill. The nearest port of entry is Chicago, Ill.

Amount of revenue collected at the nearest port of entry during the last fiscal year was \$4,169,112.52.

Money statement.

July 1, 1882, amount available.....	\$12,990 53
Amount appropriated by act passed August 2, 1882.....	20,000 00
	<hr/> 32,990 53
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	24,312 32
	<hr/> 8,678 21
July 1, 1883, amount available.....	8,678 21
Amount (estimated) required for completion of existing project.....	111,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	75,000 00

REPORT OF MR. W. H. HEARDING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE, *Milwaukee, June 30, 1883.*

SIR: The following report upon the work done at Waukegan Harbor, Illinois, during the past fiscal year is respectfully submitted :

At the date of report of June 30, 1882, the construction of the east arm or main breakwater was in progress under the contract of Messrs. Knapp & Gillen of date June 27, 1881. The extension of this arm, 200.83 feet in length by 14 feet in width, was finished by them in accordance with the terms of extension of contract, making the whole length of this arm 380.83 feet, and a riprap of large stone was placed alongside the east face of the breakwater for its whole length.

By act of Congress, August 2, 1882, the sum of \$20,000 was appropriated for the improvement of this harbor, and work was commenced upon the south pier by hired labor and purchase of materials in the open market, under the immediate charge of Mr. Samuel Whitney, United States inspector, commencing at a point 900 feet to the southward of the commencement of the north pier, and at a distance of 30 feet westward of the shore-line. The work accomplished up to December 16, 1882, was as follows :

The first section of 100 feet in length running eastward into Lake Michigan is comprised of a single row of square pine piles of dimensions 12 by 12 inches by 18 feet, with the exception of the outer 24 piles, which are 22 feet in length by 12 by 12 inches. The next outer section of 100 feet in length is constructed of round oak piles, each 30 feet in length, driven on alignment at distances of 3 feet from center to center of piles, and sheeted with two rows of planks, of dimensions 3 by 12 inches by 22 feet,

driven close and breaking joints with each other and spiked to the wales which inclose and secure the round piles. The next outer section of 109 feet in length is built with round oak piles of 30 feet each in length, driven on alignment at distances of 3 feet from center to center, inclosed between and secured with binders, and on the south side of this row 8 by 12 inches by 26 feet pine piles are driven in close contact and bolted to the binder on the south side of the main row, and reinforced with a binder of 3 by 12 inches pine timber. Thirty-four and six-tenths feet of the next section was completed and filled with stone ballast, making a total length of 343.6 feet of the south pier built in 1882. A riprap of large stone was placed alongside the north face of this pier, covering a distance of 90 feet at its outer end, and also alongside the south face of the pier for a distance of 80 feet. The outer section, of which the 34.6 feet is the commencement, is comprised of two parallel rows of oak piles driven in close contact, at a distance of 14 feet from center to center of rows, the north row being a continuation of the alignment of the preceding sections. These rows are secured and bound in place by means of wales, binders, screw-bolts, and tie-rods. On the south side of the north row a double sheeting of 3 by 12 inches by 22 feet planks are driven and secured, as in the second 100-foot section. In the continuation of this pier cross rows of round oak piles will be driven and secured with binders at distances of 32 feet from each other. The work of pile-driving was resumed on the 7th instant, and the south pier has been extended 47 feet eastward and completed, with the exception of filling this extension with stone ballast. It is expected that seven sections of 32 feet each in length or 224 feet of pier will be built this season, which will make the south pier 567 feet in length. The water-jet has been used as an auxiliary to the pile-driver in all the work at this harbor.

On the 6th instant I made a resurvey of the harbor and vicinity, the plot of which shows the changes which have been effected upon the shore-line and lake bed since operations were commenced for harbor improvement.

A large accretion of sand has formed to the northward of the harbor basin, which extends out to a distance of 225 feet from the point of commencement of the north arm, and on the south or inner side of this arm it reaches to the northeast corner of the basin. The erosion of the beach to the southward of the south pier is quite marked, and it is probable that the erosive action will be increased as the piers are extended. A bar has formed at a distance of 100 feet to the eastward of the east arm, which has undoubtedly assisted in protecting the work during the very heavy storms which have occurred since its construction. The riprap of stone which protects this work has not changed perceptibly since its first settlement.

The efficient services of Mr. Samuel Whitney, United States inspector, in the conduct of this work are deserving of notice, and I trust this brief allusion to them may not be out of place in this report.

The number of vessels which arrived and discharged cargoes at the bridge pier during the year was thirty-eight. The number of departures was thirty-eight. A large number of tow-boats and excursion steamers have made landings at the bridge pier, of which no record has been kept. The receipts and shipments of merchandise and products are chiefly conducted by railroad.

The nearest port of entry is Chicago, Ill. The nearest collection district is Chicago, Ill.

The amount of revenue collected at the nearest port of entry during the last fiscal year (customs), is reported by the Hon. Jesse Spalding, collector, to have been \$4,169,112.52.

I have the honor to subscribe myself, very respectfully, your obedient servant,
W. H. HEARDING.

Lieut. Col. D. C. HOUSTON,
Corps of Engineers, U. S. A.

F F 6.

IMPROVEMENT OF THE FOX AND WISCONSIN RIVERS.

CONDITION OF THE WORK JUNE 30, 1883.

The condition of the work is the same as stated in my last annual report, with the additional work done during the year, detailed accounts of which will be found in the accompanying reports of Capt. F. A. Hinman, Corps of Engineers, C. A. Fuller, assistant engineer, and J. W. Allen, jr., overseer.

The following is a summary of the principal work done during the year ending June 30, 1883 :

FOX RIVER.

Lower Fox.—Constructing a retaining wall for canal bank above Kaukauna first lock; laying coping on walls of said lock; quarrying, dressing, and transporting stone for new locks; commencing construction of new first lock at Appleton; commencing alteration of dams at Menasha and Appleton required by the river and harbor act of August 2, 1882; constructing a new hull for Dredge No. 1; making necessary repairs to locks, dams, and canal banks.

The work of altering the Menasha Dam was suspended on account of an order of the circuit court of Winnebago County, Wisconsin, on the application of private parties, claiming that their property would be injured. The suit was transferred to the United States circuit court for the eastern district of Wisconsin, where it is now pending.

Upper Fox.—The work of deepening and widening the channel by dredging was continued; 124,208 cubic yards were excavated and removed from the channel, and necessary repairs made to locks, dams, canal banks, &c.

WISCONSIN RIVER.

Nine thousand three hundred and twenty linear feet of wing-dams were constructed during the year, reducing the width of the low-water channel to 300 feet for a distance of nearly 10 miles below Portage. The accompanying report of Capt. F. A. Hinman, Corps of Engineers, gives the results of this work in detail.

PROPOSED APPLICATION OF FUNDS AVAILABLE FOR EXPENDITURE DURING THE FISCAL YEAR ENDING JUNE 30, 1884.

FOX RIVER.

Alterations in dams at Menasha and Appleton; construction of Appleton first lock; repairs of locks, dams, and canal banks; maintenance of works, operating locks, care of property, &c.

PROPOSED APPLICATION OF FUNDS ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1885.

The whole subject of the improvement of the Fox and Wisconsin rivers has been referred to the Board of Engineers for Fortifications and River and Harbor Improvements, and it is expected that the Board will make a report in time for the next session of Congress. Future work on the improvement will, it is presumed, depend on the report of the Board.

The estimate now submitted is for the continuation of the work on the plan heretofore pursued.

There can be profitably expended during the year ending June 30, 1885, the sum of \$500,000 in carrying out the project.

The plan adopted for this work is, for the Fox River slackwater navigation by dams and locks, and for the Wisconsin, the improvement of the natural channel of the river by means of wing-dams and dikes, so

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as to reduce the width of the river, where necessary at low water, and by thus confining the current, secure an increase of depth by the scouring action of the current.

Original estimated cost of work as now being carried on	\$3,745,663 00
Amount appropriated since adoption of present project	1,620,000 00
Amount expended since adoption of present project, i. e., since July 1, 1875	1,497,737 36
Amount exclusive of former appropriations required for entire and permanent completion of work	2,125,663 00

The nearest collection district is Milwaukee, Wis. The nearest port of entry is Milwaukee, Wis.

The amount of revenue collected at the nearest port of entry during the last fiscal year was \$192,272.53.

The object of this improvement is to establish a water route between Upper Mississippi and the lakes by which transportation will be cheapened.

The arguments on this subject are fully given in the report of Maj. G. K. Warren, Corps of Engineers, Report of Chief of Engineers for 1868, page 357, and in the report of the Select Committee on Transportation Routes to the Seaboard, United States Senate, 1874.

The amount of tolls collected during the year ending June 30, 1883, is \$625, required to be reported annually by act of Congress approved July 7, 1870. The river and harbor act of August 2, 1882, discontinued the collection of tolls.

The following papers accompany this report:

No. 1. Report of Capt. F. A. Hinman, Corps of Engineers, on Wisconsin River, dated December 13, 1882.

No. 2. Annual report of Mr. J. W. Allen, jr., overseer on Fox River, Portage to Oshkosh, dated July 6, 1883.

No. 3. Annual report of Mr. C. A. Fuller, assistant engineer on Fox River, Lake Winnebago to Green Bay, dated July 6, 1883.

Money statement.

July 1, 1882, amount available	\$47,354 10
Tolls received and deposited to credit of appropriation	625 00
Fuel sold to officers and deposited to credit of appropriation	178 75
Amount appropriated by act passed August 2, 1882	200,000 00
	<hr/>
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	248,157 85
	<hr/>
July 1, 1883, amount available	113,390 78
	<hr/>
July 1, 1883, amount available	134,767 07
	<hr/>
Amount (estimated) required for completion of existing project	2,125,663 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	500,000 00

WISCONSIN RIVER.

REPORT OF CAPTAIN F. A. HINMAN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., December 13, 1882.

SIR: In accordance with your instructions of October 31, last, I have the honor to submit the following report of operations on the Wisconsin River improvement since June 30, last. The operations of this season previous to that date were embodied in my report to you, dated July 3, last, for the fiscal year ending June 30, 1882. The plan of improvement then pursued has been adhered to since.

Work on the repairs and construction of dams (that is, sinking brush mats) was

resumed July 17 (very late in the season), and was continued until the close of the season, November 10, a period of three months and 25 days. The season throughout was very fine for work.

There was a fine channel at all stages of the river in the improved section. Plenty of laborers were obtained at fair rates, and also a sufficiency of material. No stone or brush mats were on hand on the close of operations, all being in the work. A large amount of work was done and good results obtained.

It is thought that the improvement of the river is now completed from Dam No. 1, 1878 (just above Portage City Lock), to Allen's Landing, a distance of 9.2 miles. From Portage City Bridge (a fixed one) to Allen's Landing the distance is 9.7 miles. The channel is quite good from Dam No. 1, 1878, up to the bridge, although not contracted as below. The balance of the first 12 miles of the river below Portage (23 miles from Allen's Landing to Wild Cat Bluff) will not require very much more work to complete it. It has eleven dams in it of an aggregate length of 5,355 linear feet. Probably 10 short dams would complete it. Above Allen's Landing there are one hundred and nine dams of an aggregate length of 60,022 linear feet, and six bank protections of an aggregate length of 5,938 linear feet, all of which were in good condition on the close of operations. Sixty-seven of these dams were repaired this season, some more than others of course; the repairs of quite a number consisted only of strengthening the shore protections by covering them all over with stone, as the brush part of them was not durable enough where out of water. Portions of three bank protections were likewise repaired.

Although the repairs of each dam have not been very large, with few exceptions, the repairs of the dams in the aggregate have been quite extensive.

The closing dams across Sloughs No. 1, 1873; No. 1, 1875; No. 9, 1873; No. 2, 1874; No. 1, 1871; and No. 2, 1871, were raised and strengthened so that but little water can go over them at ordinary stages, thus confining the water to one channel as much as possible.

Every wing-dam above Allen's Landing has a spur (submerged of course) and a slant. In repairing work advantage was taken of high stages to go back and repair portions of dams that were inaccessible to loaded scows at low-water. Ten dams were built of an aggregate length of 5,815 linear feet, and nine were extended 3,505 linear feet, making a total length of new work of 9,320 linear feet. The amount of work done on each dam or bank protection cannot be shown by time very well, but can best be seen by a table giving the approximate amounts of material used in each work as follows:

List of dams and bank protections repaired in 1882, and the approximate amount of materials in each.

[The dams marked with an * were also extended. The materials used in the repairs and extensions of these are given in the table of dams extended.]

Dam.	Stone.	Brush.	Dam.	Stone.	Brush.	Dam.	Stone.	Brush.
	<i>Cords.</i>	<i>Cords.</i>		<i>Cords.</i>	<i>Cords.</i>		<i>Cords.</i>	<i>Cords.</i>
*Old Jetty.			No. 4, 1874	33	108.25	No. 20, 1880	4	17.75
No. 1, 1871	20	57	No. 1, 1875	18	63	No. 26, 1880	3	7.75
No. 2, 1871	83	262.25	No. 2, 1875	10	.....	No. 27, 1880	21	62.50
No. 3, 1871	3	14.50	No. 4, 1875	11	31.50	No. 28, 1880	4	.....
No. 4, 1871	21	83	No. 5, 1875	20	69.75	No. 29, 1880	47	174.25
No. 5, 1871	2.5	10	No. 6, 1875	3	10.50	No. 30, 1880	10	30
*No. 6, 1871	.....	.....	No. 9, 1875	12	50.50	No. 31, 1880	13	25
No. 7, 1871	11	44	No. 10, 1875	20	64.75	No. 3, 1881	1	2
*No. 9, 1871	.....	.....	No. 11, 1875	4	19.25	No. 5, 1881	1	2.50
*No. 11, 1871	.....	.....	No. 12, 1875	67.5	204	No. 6, 1881	2	10.75
No. 12, 1871	22	75.50	No. 15, 1875	1.5	10.75	No. 10, 1881	5	22.25
No. 2, 1872	42	203.75	No. 1, 1878	11	25	No. 11, 1881	1	2.50
*No. 5, 1872	.....	.....	No. 1, 1878	19	53.15	No. 12, 1881	12	40.25
No. 1, 1873	17	85.50	No. 2, 1880	11	11	No. 13, 1881	4	19.25
*No. 3, 1873	.....	.....	No. 3, 1880	18	49	No. 15, 1881	3	.....
No. 4, 1873	1	4.75	No. 4, 1880	1	.....	No. 17, 1881	3	5.75
No. 6, 1873	7	23.75	No. 7, 1880	8	42.75			
No. 7, 1873	10	42.25	No. 8, 1880	4	3			
No. 8, 1873	8	18.50	No. 10, 1880	4	8.75			
No. 9, 1873	36	103.50	No. 11, 1880	3.5	14.50			
No. 10, 1873	37.5	116.75	No. 12, 1880	5.5	10.25			
No. 13, 1873	3	9.50	No. 13, 1880	11	35	No. 2, 1878	2	8.5
No. 14, 1873	6	14.25	No. 15, 1880	27	92.75	No. 1, 1875	8	.....
No. 2, 1874	12	28	No. 16, 1880	7	17.25	No. 2, 1875	10
No. 2, 1874	44	126	No. 17, 1880	1	4.50			
No. 3, 1874	9	15				Total	878.0	2,742.50

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List of dams built and extended in 1882.

Dams built.				Dams extended.			
Dam.	Length.	Approximate materials.		Dam.	Length of extension.	Approximate materials.	
		Stone.	Brush.			Stone.	Brush.
	<i>Lin. feet.</i>	<i>Cords.</i>	<i>Cords.</i>		<i>Lin. feet.</i>	<i>Cords.</i>	<i>Cords.</i>
No. 1, 1882	445	50	304. 75	Old jetty	300	63. 5	226. 75
No. 2, 1882	576	73	282. 50	No. 6, 1871	208	35. 5	127. 75
No. 3, 1882	646	74	324. 75	No. 9, 1871	570	114	431. 50
No. 4, 1882	420	115	371	No. 11, 1871	276	47	201. 25
No. 5, 1882	1, 079	181	544. 50	No. 5, 1872	926	79. 76	591. 75
No. 6, 1882	586	84	334. 25	No. 3, 1873	296	3	4
No. 7, 1882	789	112	466. 25	No. 14, 1875	363	93	343. 75
No. 8, 1882	492	86	117. 25	No. 18, 1880	312	43	216. 50
No. 9, 1882	379	36	131	No. 18, 1881	264	29	118. 50
No. 10, 1882	403	85	335. 25				
Total	5, 815	796	3, 111. 50	Total	3, 505	507. 76	2, 206. 75

Table showing durations of different stages of water in the Wisconsin River at Portage above or below General G. K. Warren's zero, 3 feet above miller-sill, for the year 1882.

[The figures represent days except when otherwise specified.]

Month.	Depth extreme low water to 0.	Depth 0 to 1 foot.	Depth 1 to 2 feet.	Depth 2 to 3 feet.	Depth 3 to 4 feet.	Depth 4 to 5 feet.	Depth 5 to 6 feet.	Depth 6 to 7 feet.	Total number days.	Extreme low water.	Extreme high water.	Remarks.
March			5	26					31	<i>Feet.</i>	<i>Feet.</i>	It will be noticed that low water exists for only a few days in the year. During the past three years it has been below Warren's zero at Portage but fourteen days.
April					8	12	4	6	30	0-1.6	1	
May				10	16	5			31			
June			7	21	2				30			
July			10	21					31			
August		16	15						31			
September	3	19	8						30			
October	6	1	4		5	9	4	2	31	0-0.3		
November				12	11	4	3		30			
Totals	9	36	49	95	46	25	9	6	275			

Soundings were made, in the manner heretofore explained, in the deepest part of the channel of the improved section on five different occasions. Reliance was necessarily placed on the judgment of the pilot to select the deepest channel while the steamboat from which the soundings were made was moving up-stream. The soundings were located on lines comparatively short, run between points well defined on the map.

The high-water channel lines do not always coincide with those at low water, as the river runs straighter during high water than at low water; nor do the lines always coincide at low water, as a pilot cannot run the same course twice with exactness. Small, shifting sand bars change the channel some, as the tendency is to draw the sand from a bar on the right (or left) to the deep water below, on the left (or right), thus reversing the longitudinal channel curves from time to time, the general directions of the deep-water channel, however, remaining about the same in most cases. Bars necessarily move more rapidly and change quicker where the dams are than in the natural river. Progress maps with these soundings plotted thereon have already been submitted to you; they are explanatory of themselves.

Table showing comparison of soundings (without reduction).

Date of sound- ings.	Warren's gauge readings at Fort- age.	Dekorra gauge readings.	Number of miles sounded.	Location of soundings.	Total number of soundings.	Number of soundings feet or more.	Number of soundings less than—											Number of bare less than—			
							5.0 feet.	4.9 feet.	4.8 feet.	4.7 feet.	4.6 feet.	4.5 feet.	4.4 feet.	4.3 feet.	4.2 feet.	4.1 feet.	4.0 feet.	Least soundings.	3 feet.	4 feet.	
1882.		Feet.																			
June 23	0+2.5	0+3.2	7.1	Dam No. 1, 1878, to Dekorra	474	458	16	15	14	9	8	5	5	4	4	1	0	0	4	0	0
Aug. 7	0+1.5	0+2.2	7.1	Dam No. 1, 1878, to Dekorra	628	624	2	1	0	0	0	0	0	0	0	0	0	0	4.8	1	0
Aug. 28	0+0.4	0+1.45	7.3	Dam No. 1, 1878, to Dam No. 3, 1882.	678	629	49	37	28	23	19	13	6	3	2	0	0	0	4.1	9	0
Sept. 22	0-0.15	0+1.4	7.9	Dam No. 1, 1878, to Dam No. 5, 1882.	884	723	111	63	77	71	63	46	27	19	6	4	0	0	4.0	21	0
Nov. 6	0+2.45	0+3.6	9.7	Portage City Bridge to Allen's Landing.	614	613	1	1	1	0	0	0	0	0	0	0	0	0	4.7	1	0
Nov. 6	0+2.45	0+3.6	9.7	Portage City Bridge to Allen's Landing.	614	614	1	0	0	0	0	0	0	0	0	0	0	0	4.9	1	0

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The above table shows the soundings were made at high and low stages. That of September 22 was but 0.45 foot above the lowest on record at Portage (0.06 foot in 1877) 0.06 above the lowest for 1881, and 0.15 below the lowest for 1880, and yet no sounding was obtained less than 4 feet in a continuous distance of 7.9 miles. No sounding on any of the lines was less than that.

On November 6 two lines of soundings were made the width of the boat apart, 38 feet. They were made simultaneously on each side of the boat. They were taken during the only big rise of the working season, which did not go down in time to get another set of low-water soundings before the close of operations. The work was in fine shape for this rise to clear out the channel, which it probably will do. On September 22 the water was 0.55 foot lower on the Portage gauge than on August 28; while on the Dekorra gauge, on the same dates, there was but a trifling difference.

The bench established at Dekorra in the spring of 1880 is on the rocky bluff near the mouth of Rocky Run. It is marked X—III—II—II, and is the dash between X and III. It is 2.566 feet higher than the top of the upper miter sill of the Portage City Lock, the bench at Portage City. The zero of the Dekorra gauge is 12.322 feet below the Dekorra bench. Warren's gauge at Portage is 3 feet above the top of the upper miter sill of Portage City Lock, and 0.2 foot below the zero of the present gauge at Portage City Lock.

The following is submitted with reference to gaugings. The places chosen were good ones; the river flowed through them straight; was free from eddies, and about 300 feet in width. The old place above the canal had so changed that it could not be used for gauging:

Table of gaugings of the Wisconsin River.

AT PORTAGE, 1882.

No.	Locality.	Date.	Warren's gauge at Portage.	Number of floats.	Discharge per second.	Discharge per second reduced to Warren's zero.	Mean discharge per second reduced to Warren's zero.	Value of $\frac{1}{10}$ of a foot per second.
			<i>Feet.</i>		<i>Cub. ft.</i>	<i>Cub. ft.</i>	<i>Cub. ft.</i>	<i>Cu. ft.</i>
1	At dam No. 2, 1873, below lock gates and valves closed	Sept. 30	0+0.05	11	3,469	3,429	3,347	80
2	.....do	Oct. 2	0-0.1	11	3,286	3,366	
3	.....do	Oct. 3	0-0.2	11	3,110	3,270	
4	.....do	Oct. 4	0-0.25	11	3,119	3,319	
5	.....do	Oct. 7	0+0.85	12	4,032	3,352	

AT DEKORRA, 1882.

No.	Locality.	Date.	Dekorra gauge reading.	Number of floats.	Discharge per second.	Discharge per second reduced to 0+1.5 on Dekorra gauge.	Mean discharge per second reduced to 0+1.5 on Dekorra gauge.	Value of $\frac{1}{10}$ of a foot per second.
			<i>Feet.</i>		<i>Cub. ft.</i>	<i>Cub. ft.</i>	<i>Cub. ft.</i>	<i>Cu. ft.</i>
1	Dam No. 11, 1881, just below Rocky Run	Sept. 29	0+1.4	11	3,214	3,377	3,369	163
2	.....do	Sept. 30	0+1.4	11	3,181	3,344	
3	.....do	Oct. 1	0+1.25	11	2,862	3,358	
4	.....do	Oct. 2	0+1.3	11	2,116	3,442	
5	.....do	Oct. 3	0+1.2	11	2,885	3,374	
6	.....do	Oct. 4	0+1.15	11	2,843	3,418	
7	.....do	Oct. 7	0+2.0	12	4,186	3,371	

The value of 0.1 on each gauge at low water was found by taking a mean of the values of 0.1 foot as determined by subtracting each discharge from the maximum discharge, and dividing by the difference between the corresponding gauge readings.

In my last annual report I stated that the volume of the discharge at Portage had become fixed when the stage of water was zero on Warren's gauge. This statement is now further confirmed as the difference between the mean discharge reduced to

Warren's zero for 1881, and that for 1882 is only 81 cubic feet, which corresponds to a change of but one-tenth of a foot in the water plane, virtually no change, as there may have been errors of observation.

The water plane has raised at Dekorra 0.28 foot since 1881 (i.e.) $3820 - 3369 \div 163$, which agrees with Baumgarten's experience on the Garonne. The most of this season's work has been in the vicinity of Dekorra. Three snags and three leaning trees were removed from the channel. There are a few snags that are somewhat in the way at low water, which should be removed by a clam-shell dredge if they do not disappear in due time, also the part of Dam No. 11, 1871, that is in the middle of the channel.

SUMMARY STATEMENT OF WORK DONE SINCE JUNE 30, 1882.

Built 10 dams, 5,815 linear feet. } 9,320 linear feet.
 Extended 9 dams, 3,505 linear feet. }
 Repaired 67 dams.
 Repaired 3 bank protections.
 Pulled 3 snags, felled 3 leaning trees, &c.

Very respectfully, yours,

F. A. HINMAN,
Captain of Engineers.

Lient. Col. D. C. HOUSTON,
Corps of Engineers, U. S. A.

FOX RIVER.

REPORT OF MR. J. W. ALLEN, JR., OVERSEER.

APPLETON, Wis., July 6, 1883.

COLONEL: I have the honor to submit the following report of operations upon the improvement of the upper Fox River for the year ending June 30, 1883.

Navigation was continued without interruption the entire length of the river, until closed by ice November 30. The river was free from ice April 15 and the locks were opened on that date; there has been no interruption to navigation since then.

There has been a channel of not less than 4 feet of water on the Upper Fox since navigation opened this spring, the water in the river having been at a good stage. At ordinary low water there would be a 3-foot channel between Portage and Oakkosh.

Repairs were made to the several locks and dams as required.

Dredging was done on the bars which offered the greatest obstruction to navigation, to maintain as good a channel over the whole section as was practicable.

In the White River level dredging was resumed at the point where work stopped in the fall of 1881, and was continued until the dredges were laid up. This work has for its object permanently lowering the bed of the river.

Extensive repairs were made to dredges Nos. 3, 4, 5, and 7 during the winter.

There has been no work done since the opening of navigation, the lock tenders at the several locks being the only men employed.

The following is a statement in detail of the work done:

I.—PORTAGE CITY LOCK AND CANAL.

There were no repairs needed during the year. Several small bars were removed from the canal.

II.—FORT WINNEBAGO LOCK (OLD).

The hangings of one of the lower gates was changed, a diamond block and continuous suspension rods being put on.

III.—GOVERNOR BEND LOCK AND DAM (OLD).

This is an old crib lock and is in very bad condition. Purchase blocks were put on the upper gates to enable the lock-tender to operate the lock against the head caused by leakage through the walls. The dam is in good condition.

IV.—MONTELLO LOCK AND DAM (OLD).

The lock and dam at this place are both old crib structures. Slight repairs were made to the planking of the lock. A leak around the south abutment of the dam was stopped with shingle sawdust, brush, and stone.

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V.—GRAND RIVER LOCK AND DAM (NEW).

This is a new stone lock, as are also the four others below here, and is in good condition. The temporary brush dam at this has settled so as to be much lower than it is intended to have the permanent dam when built, but it was not raised, as boats experienced no difficulty in this level.

VI.—PRINCETON LOCK AND DAM (NEW).

The lock-tender's house here was damaged by lightning so that it was necessary to rebuild one of the chimneys and a portion of the roof.

The dam here, like those at Grand River, White River, and Berlin is a temporary one, built of brush mats and stone ballast. It was found to have settled considerably at the north end. Additional brush and stone were put on to bring it to its original height.

VII.—WHITE RIVER LOCK AND DAM (NEW).

Repairs were made to the north end of this dam similar to those made at Princeton. Embankments were thrown up on each side of the lock to prevent the river at a high stage from overflowing the filling back of the lock walls.

VIII.—BERLIN LOCK AND DAM (NEW).

A break in the canal bank here was filled by stopping the flow of water with brush and stone, and covering this with earth. Four thousand eight hundred and twenty-three cubic yards of earth were put in this break by Dredge No. 3. The river banks above the dam were protected with brush and stone.

IX.—EUREKA LOCK AND DAM (NEW).

The canal banks above the lock were protected from washing by covering them with gravel. Repairs were made to the lock-tender's house to make it habitable during the winter.

X.—DREDGING.

Dredge No. 2 was fitted out and transferred to the Lower Fox River September 13, 1882.

Dredge No. 3 worked from September 18 to November 11, 1882.

Dredge No. 7 was at work at the beginning of the year, and continued dredging until November 16, 1882.

Dredges Nos. 4, 5, and 6 were not fitted out, as the late date at which they would be ready for work did not warrant their being put into commission.

Of the 124,208 cubic yards of material excavated and permanently removed during the season, 86,831 cubic yards were excavated by dredge No. 7, 4,890 cubic yards of this being handled twice, and 37,377 cubic yards were excavated by dredge No. 3.

Four thousand eight hundred and twenty-three cubic yards were dredged at Berlin Lock for the purpose of stopping a break and strengthening the canal bank.

Fifty-three thousand five hundred and ninety-five cubic yards were dredged in clearing the channel between Portage and Berlin. This work was done on twenty different bars, and was principally at points where no dredging had been done for the purpose of permanently deepening the channel. The exceptionally high water in the fall of 1881 caused by the overflow of the Wisconsin River into the Fox River was the cause of a much greater disturbance of the river bed and the formation of more bars than would have taken place ordinarily. In this connection it will be of interest to notice that the State of Wisconsin, assisted by the United States, has completed a levee at Lewiston to prevent this overflow of the Wisconsin River, and it is probable that the same causes for high water will not again occur.

Sixty-two thousand six hundred and twenty-eight cubic yards of material, chiefly hard gravel and sand, were excavated in the level above White River Lock in permanently deepening the channel. Of this quantity 4,890 cubic yards were handled twice.

The side-wheel steamer Portage was in commission at the beginning of the year, and was employed until November 16 in towing and tending dredges, and in towing material for repairing dams and canal banks. The boat was also placed at the disposal of the commission for ascertaining damages to lands by flowage, and was employed by them at intervals during the summer in viewing the lands.

XI.—REPAIRS TO BOATS AND DREDGES.

Dredge No. 3.—General repairs were made to the machinery of this dredge. New oak blocks and braces were put in the crane.

Dredge No. 4.—Wrought-iron spokes were put in the friction gears; cast-iron knees

were put in the derrick frame; general repairs were made to the machinery. The hull was strengthened under the frictions and derrick by trusses.

Dredge No. 5.—A new crank-shaft was put in. The cast-iron friction, V, was turned off, and new maple frictions put in. General repairs were made to machinery.

Dredge No. 7.—The cast-iron frictions were turned off smooth, and new maple friction blocks put in. Unsound timber in the derrick was removed, and new substituted in its place. The hull was strengthened by trussing under the frictions and derrick.

The steamer Portage was hauled out and placed on blocking. This boat has done good service, and should have a new hull.

Very respectfully, your obedient servant,

J. W. ALLEN, JR.,
Overseer.

Lient. Col. D. C. HOUSTON,
Corps of Engineers, U. S. A.

REPORT OF MR. C. A. FULLER, ASSISTANT ENGINEER.

UNITED STATES FOX RIVER IMPROVEMENT,
Engineer Office, Appleton, Wis., July 6, 1883.

COLONEL: I have the honor to submit the following report of operations on the improvement of the Lower Fox River for the fiscal year ending June 30, 1883:

Operations during the year were confined principally to constructing a retaining-wall above the head of Kaukauna First Lock; to laying the coping on walls of Kaukauna First Lock; to dressing stone at Kaukauna for Kaukauna First and Appleton First Locks, and transporting same to the lock-sites; to commencing the construction of a new lock at Appleton; to commencing the alterations in the Menasha and Appleton dams, required by the Secretary of War on recommendation of a Board of Engineers; to constructing a hull and upper works for Dredge No. 1, and to making necessary repairs to locks, dams, and canal banks.

Navigation was continued without interruption until closed by ice on November 30, 1882. It was resumed on the 29th of April, 1883, except through the five Kaukauna locks, and throughout the line on the removal of the coffer-dam at Kaukauna on the 16th of May. Boats drawing 5 feet of water could run from Green Bay to Menasha, and 4 feet thence to Lake Winnebago during the whole season of navigation.

The following outline of operations at each point on the Lower Fox River is respectfully submitted:

1.—DE PERE DAM (NEW).

No work was done on this dam during the year. A backing of clay and gravel, on a layer of willow mats, is required to complete the work.

2.—DE PERE LOCK (OLD).

A leak through the left head wall (crib and embankment) was stopped by driving sheet-piling and filling with clay. One hundred and fifty-one cubic yards of clay, three loads of sawdust, and 111 feet, B. M., of hemlock plank were purchased and expended in making the repairs.

3.—LITTLE KAUKAUNA LOCK (OLD).

Two old wooden capstans were replaced by iron ones; four capstan platforms and one diamond block repaired; three new snubbing-posts were put in and two old ones reset.

4.—LITTLE KAUKAUNA DAM (NEW).

A leak at the east end was stopped by long sawdust filling and clay puddling. Two hundred and sixty-three cubic yards of heavy stone were transported from Kaukauna quarry and placed against the tower side, where the piles had been moved out of line by high water.

5.—RAPID CROCHE LOCK (OLD).

Capstan platforms were repaired, two new arms were placed in one of the tower gates, and the toe-post was repaired.

6.—RAPID CROCHE DAM (NEW).

No further cutting of river bank at the south end of the dam has taken place. It is proposed to make the required repairs during the coming low-water season.

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7.—KAUKAUNA QUARRY.

Work was resumed at this point August 22, 1892. A derrick was erected on the canal wharf and rigged. The quarry pump and engine were set, and tools and plant hauled to the quarry; 1,561 cubic yards of stone were taken out and transported to stone yard, and 6,876 cubic yards of clay, bowlders, and hardpan were stripped and removed. Quarrying was suspended December 2, 1892, and the pump removed, the engine laid up, and tools stored.

8.—KAUKAUNA FIFTH LOCK (OLD).

One lower gate was repaired and a new diamond block placed.

9.—KAUKAUNA FOURTH LOCK (NEW).

Three thousand eight hundred and fifty superficial feet of walls were repointed and the wing-walls repaired.

10.—KAUKAUNA THIRD LOCK (NEW).

Two thousand seven hundred superficial feet of walls were repointed.

11.—KAUKAUNA SECOND LOCK (OLD).

The chamber walls were repaired, a new spar, turn-buckle, and goose-neck were put on upper gate, and the upper slope-wall repaired.

12.—KAUKAUNA FIRST LOCK (NEW).

The coping of the walls, except in the south recess, was laid; 376.5 linear feet of 19-inch coping, five round corners, two hollow quoins, 42 superficial feet of slope-wall, and 26 linear feet of slope-coping for steps were dressed at Kaukauna quarry for this lock.

A retaining-wall was built, extending 140 feet up the canal bank, from the head of the lock; 441 cubic yards of cement masonry were laid, 804 cubic yards of clay and stone were excavated to bed-rock, and 1,046 cubic yards of clay filled in behind the wall and puddled. The wall was completed and the coffer-dam removed on the 16th May, 362 barrels of cement were purchased and expended on the wall. The lock is completed except laying recess coping, steps, and slope coping, pointing and doweling coping, placing suspension columns and maneuvering-gear for gates, placing iron snubbing-posts, and filling behind the walls. Four iron suspension columns, six iron snubbing-posts, four tripods, and racks for opening and closing gates were purchased and received.

13.—KAUKAUNA DAM (NEW).

A leak near the north abutment was stopped and the canal bank near the abutment was repaired.

14.—LITTLE CHUTE COMBINED LOCKS (NEW).

The coping and walls of these locks were repointed.

15.—LITTLE CHUTE SECOND LOCK (NEW).

No repairs were required.

16.—LITTLE CHUTE FIRST LOCK (OLD).

Two new diamond blocks were made and placed and the capstan platforms repaired.

17.—LITTLE CHUTE DAM (NEW).

Slight repairs were made at the south abutment.

18.—CEDARS LOCK (OLD).

The old wooden capstans were replaced by iron ones.

19.—CEDARS DAM (OLD).

The extreme high water of May, 1893, caused a washout between the abutment and the right bank of the river to a width of about 50 feet. Water has flowed continuously through this break to the present time, but there has been but little further cutting of the bank. It is proposed to make the required repairs at this point during the coming low-water season.

20.—APPLETON FOURTH LOCK (OLD).

The capstan platforms were repaired and a portion of the chamber walls replanked.

21.—APPLETON LOWER DAM (OLD).

About one-half of the coping timbers of this dam have been carried off by high water. New ones should be put on during the next low-water season.

22.—APPLETON THIRD LOCK (OLD).

A leak at the head of the lock was stopped, and capstan platform repaired.

23.—APPLETON SECOND LOCK (NEW).

One spar and one capstan platform were repaired. New hand-rails were put on, and the gates repaired.

24.—APPLETON FIRST LOCK (OLD).

A coffer-dam was put in below the lock, and one on the breast-wall. The water was pumped out, the engine running night and day; 2,000 superficial feet of the south wall was replanked, the upper and lower miter-sills rebolted, and recess walls planked; 36 cubic yards of dry wall was taken down, rebuilt, and lined with plank below the water-line; 10 cubic yards of concrete at foot of side wall were put in, and sheet piling driven along the upper wing-wall. The south wall was subsequently strengthened with dry-stone masonry and heavy oak shores, set on solid rock.

25.—APPLETON FIRST LOCK (NEW).

An earthen coffer-dam was built above the lock site, and a crib coffer-dam put in below. Dredge No. 2 partly excavated the lock-pit, and the excavation was completed by manual labor. Pumps and engines were set, and kept running day and night. Four derricks were set for constructing walls, and one for unloading stone. A dock and tramway were built. Four lock-gates were framed, and the gate-irons made. Two miter-sills were constructed, and the lower one set and bolted with seventeen 1½-inch bolts to bed-rock; 2,069 cubic yards of clay and gravel were excavated, and 90 cubic yards of rock taken out; 425 cubic yards of cement masonry were laid in foundations and backing, 55.4 cubic yards in breast-wall, and 132 cubic yards of puddling put in behind the walls.

Four hundred and forty-nine linear feet of 14-inch, 10.7 linear feet of hollow quoins, 10.8 linear feet of round corners, and 9.5 linear feet of valve recess stones were dressed pitched face, and 22 linear feet of 19-inch coping, 35 linear feet of breast-wall coping, four hollow quoins, four round corners, and four valve recess-stones were hammered dressed at Kaukauna for this lock. There were received from Kaukauna quarry 286 cubic yards of backing stone, 5.2 cords of rubble, and 449 linear feet of pitched face stone. From Cedars 58.5 cubic yards of backing, and from Appleton 59 cubic yards.

There were purchased 14,090 feet, B. M., pine lumber, 971 barrels of cement, 3,187 pounds of iron, 270 pounds miter-sill castings, six iron recess-valves, four iron suspension columns, six iron snubbing-posts, four tripods and racks for opening and closing gates, sixty-four pounds drift bolts, and three kegs spikes.

26.—ALTERING APPLETON UPPER DAM.

To lower the crest of this dam 18 inches a coffer-dam extending 152 feet in length, from the south end of the dam, was put in the stone coping and two courses of backing removed, 25 cubic yards of masonry laid, to level up, and 103 linear feet dressed to receive timber. Holes were drilled for anchor bolts; fifteen bolts set, and top timbers framed. Work was suspended December 4, 1882.

To permit the flow of the river during extreme high water in May, 1883, the top of the wall in rear of the coffer-dam was protected with concrete and the coffer-dam partly removed.

There were purchased and expended 21,502 feet, B. M., pine lumber, 415 pounds drift bolts, 913 pounds iron, and four kegs of nails. There were also purchased, but not expended, 662 pounds iron brackets and eye-bolts.

27.—ALTERING MENASHA DAM.

To lower the crest of this dam 18 inches a coffer-dam was placed on the upper edge of the backing, 150 feet of the crest removed, 548 cubic yards of gravel and stone backing taken out, timbers removed from the old crib work and replaced by new, the crest lowered 18 inches, crest timber put on, planking replaced, and flush-boards, 18 inches in height, placed and secured. Twelve hundred and seven cubic yards of clay and gravel were excavated for the extension of the dam north of the Coral Mill, and

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framing of timber for the cribs commenced. The work was stopped by order of the circuit court, and has not since been resumed.

There were purchased and expended on alterations of the old dam, 2,712 feet, B. M., pine lumber, 662 feet, B. M., clear plank for flush boards, 418 pounds drift-bolts, four kegs nails and spikes, and 380 pounds of bolts, for flush boards.

There were purchased for the new portion of the dam 31,155 feet, B. M., pine lumber, 2,535 pounds of iron drift-bolts, and 1,050 pounds of spikes.

28.—MENASHA LOCK (OLD).

Suspension straps to lower gates were repaired, and leaks through the lock walls temporarily stopped.

29.—DREDGING.

Dredge No. 2 was towed from Oshkosh by the steamer *Henrietta*, on the 14th September, 1882, and was employed in backing coffer-dams and excavating lock-pit for the new lock at Appleton; in removing logs and timber from the second level of Appleton canal; in taking out old guard-gates and a stone wall from the upper end of first level of Kaukauna Canal; in widening and deepening the dredge cuts below Little Kaukauna and Rapid Croche locks, and was towed to Appleton by the *Henrietta* and laid up for the season. The boat was put temporarily in commission in May, 1883, to remove the coffer-dam above Kaukauna First Lock, and has since deepened the channel near Appleton Lower Dam.

30.—SURVEYS.

A survey of the old canal and vicinity at Neenah was made, and a map and estimate of cost of proposed new canal completed. The site for a new lock to be constructed alongside of Appleton First Lock was surveyed, field-notes plotted, and the lock located. Drawings and estimate of cost of coffer-dam required in constructing a new lock at Menasha were made. Soundings of the river between Neenah and Menasha and Appleton were taken. Level lines were run from Appleton to Menasha Dam, and from Neenah Dam to Little Lake Buttes des Mortes, soundings were taken at all bridges, and obstructions in the Menasha River located. Cross-sections were made of the river at Oshkosh, Menasha, Neenah, and Appleton, and velocities of currents taken simultaneously for calculating discharges.

Lengths of all the dams on the Lower Fox were measured and gauges set up giving the height of water on each and readings noted. A map of the Neenah Channel, between Lake Winnebago and Little Lake Buttes des Mortes, was made.

31.—CONSTRUCTING HULL AND UPPER WORKS FOR DREDGE NO. 1.

A hull and upper works was built for this boat at Appleton, and the machinery from the old boat repaired and set up, with exception of the turn-table and dipper arm.

There were purchased and expended on this work 15,216 feet, B. M., oak timber, 12,522 feet, B. M., pine lumber, 4,140 pounds of iron, 292 pounds nuts and washers, 4,226 pounds of castings, thirty-five tamarac knees, ten bales of oakum, three barrels of pitch, 100 pounds white lead, and 5 gallons of boiled oil.

32.—MISCELLANEOUS.

Repairs were made to canal banks at Depere, Little Kaukauna, Rapid Croche, Kaukauna, Little Chute, and Appleton.

The steamers *Henrietta* and *General Meade* were employed in transporting materials for works in progress. Slight repairs were made to both boats during the year.

The old crib-locks, as usual, require frequent repairs to keep them in working order, and should be replaced by new ones. In replacing these locks, I would respectfully suggest that the new ones be constructed in the following order, viz, Menasha, Appleton 3d, Kaukauna 2d, Appleton 4th, Cedars, Little Kaukauna, Kaukauna 5th, and Depere. The old stone lock at Rapid Croche must be increased in length 10 feet to give it the capacity of the new locks.

In addition to constructing new locks the following work is required to be done to complete the improvement of the Lower Fox River, viz, constructing a new dam at Menasha with sluice-ways or putting sluice-ways in the old dam and building an extension; placing sluice-ways in the Appleton Upper Dam and replacing the Appleton Lower Dam by a new one; placing wires in Rapid Croche and Little Kaukauna dams; deepening the canals and the channel of the river to 6 feet at low water by dredging and by excavating through two rock bars, strengthening and paving the canal banks throughout the line, and building dwellings for the lock-tenders.

Very respectfully, your obedient servant,

C. A. FULLER,
Assistant Engineer.

Lieut. Col. D. C. HOUSTON,
Corps of Engineers, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., August 8, 1882.

SIR: The river and harbor act of August 2, 1882, provides—

That the Secretary of War shall, without delay, cause the channel of the Lower Fox River between Lake Winnebago and the Upper Government Dam at Appleton to be restored to its natural width and capacity, and shall cause such changes and alterations to be made in the dams at Menasha and Appleton, not inconsistent with security to navigation, as may be necessary to reduce to and maintain the waters of Lake Winnebago and Little Buttes des Morteaux, respectively, at their natural height; and a sufficient amount of said sum appropriated is made immediately available.

It would be more satisfactory to the interest concerned, as well as more desirable on other accounts, that the plans for carrying out this provision be determined by a Board of Officers, rather than by the officer in charge of the improvement. I have, therefore, the honor to recommend that I be authorized to convene a Board of Officers for this purpose, to meet at Oshkosh, Wis., and to be composed as follows: Lieut. Col. D. C. Houston, Maj. H. M. Robert, Maj. W. H. H. Benyaurd.

Very respectfully, your obedient servant,

H. G. WRIGHT,
*Chief of Engineers,
Brig. and Bvt. Maj. Gen.*

Hon. ROBERT T. LINCOLN,
Secretary of War.

[Indorsement.]

WAR DEPARTMENT, *August 12, 1882.*

The recommendation of the Chief of Engineers is approved.
By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

PRELIMINARY REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., September 1, 1882.

GENERAL: The Board of Engineers constituted by Special Orders No. 81, Headquarters Corps of Engineers, August 16, 1882, to consider and report upon the following provision in the late river and harbor act, viz:

That the Secretary of War shall, without delay, cause the channel of the Lower Fox River, between Lake Winnebago and the Upper Government Dam at Appleton, to be restored to its natural width and capacity, and shall cause such changes and alterations to be made in the dams at Menasha and Appleton, not inconsistent with security to navigation, as may be necessary to reduce to and maintain the waters of Lake Winnebago and Little Buttes des Morteaux, respectively, at their natural height,

has the honor to submit the following preliminary report:

The Board visited Oshkosh on the 30th ultimo, having previously gone over the Fox River and Lake Winnebago from Appleton to Oshkosh and examined the works at Appleton, Menasha, and Neenah. The Board met at Oshkosh a number of citizens from that place and Fond du Lac.

It is understood that one, if not the principal, object of the proviso

is to prevent, as far as possible, the recurrence of high water on Lake Winnebago such as occurred in the fall of 1881. As immediate action is directed, the Board would recommend, for the present, that the embankment over the north end of the Menasha Dam (see House Ex. Doc. No. 93, Forty-seventh Congress, first session, Plate 1) be removed, and that the dam at Menasha and the Upper Government Dam at Appleton be lowered 18 inches below the crests, and that provision be made to raise the dams in low water by appliances which can readily be removed and which shall be subject to the control of the Government. The dams will be in part movable.

This recommendation has reference solely to the relief of the people on the shores of Lake Winnebago and the Fox River from the disastrous effects of floods.

The Board is not now prepared to report fully on the subject referred to it, as certain examinations and surveys, authorized in your letter of instructions, are necessary; but the work now proposed will not interfere with the execution of any plans which the Board may finally recommend, and will be a commencement of the work necessary to carry out the requirements of the law.

Respectfully submitted.

D. C. HOUSTON,
Lieut. Col. Engineers, Bvt. Col.
HENRY M. ROBERT,
Major Engineers.
W. H. H. BENYAURD,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
September 9, 1882.

Respectfully submitted to the honorable the Secretary of War.
The views and suggestions of the Board are concurred in by this office and recommended for approval.

JOHN G. PARKE,
Acting Chief of Engineers.

[Second indorsement.]

Approved.

ROBERT T. LINCOLN,
Secretary of War.

SEPTEMBER 16, 1882.

LETTER TRANSMITTING REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., October 30, 1882.

GENERAL: I have the honor to forward herewith report of the Board of Engineers constituted by Special Orders No. 81, Headquarters Corps of Engineers, August 16, 1882, with a tracing, sent in a separate package.

The last clause in the report refers to the alterations in the Menasha Dam, recommended in the preliminary report as well as in the present

report. It is a question, *first*, whether the Government is liable for damages which it is alleged will be caused by these changes, and, *second*, if so, how the amount shall be ascertained.

The order of the circuit court to Mr. C. A. Fuller, assistant engineer, to desist and refrain from carrying out the recommendations of the Board, reported by me on the 7th instant, was discontinued on the 19th, at the instance of the plaintiffs. Work has been commenced on the dams at Menasha and Appleton.

I am, general, very respectfully, your obedient servant,

D. C. HOUSTON,
Lieut. Col. of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., October 30, 1882.

GENERAL: The Board of Engineers constituted by Special Orders No. 81, current series, from Headquarters Corps of Engineers, to consider and report upon the proviso in the river and harbor act passed August 2, 1882, relating to the improvement of the Fox and Wisconsin rivers, has the honor to submit the following report in addition to the preliminary report dated September 1, 1882.

The proviso in question is as follows:

Provided, That the Secretary of War shall, without delay, cause the channel of the Lower Fox River, between Lake Winnebago and the Upper Government Dam at Appleton, to be restored to its natural width and capacity, and shall cause such changes and alterations to be made in the dams at Menasha and Appleton, not inconsistent with security to navigation, as may be necessary to reduce to and maintain the waters of Lake Winnebago and Little Buttes des Morts, respectively, at their natural height, and a sufficient amount of said sum appropriated is made immediately available.

The first clause of this proviso requires that the channel of the Lower Fox River between Lake Winnebago and the Upper Government Dam at Appleton shall be "restored to its natural width and capacity," a literal interpretation of which would require the removal of all dams, bridges, and the encroachments upon the natural channel of the Lower Fox River, between the points mentioned, such as the dams at Menasha and Neenah, a large portion of the mills at Menasha, and the piers of the various bridges, and it is a question whether it does not also require the removal of the upper dam at Appleton.

The second clause of the proviso is as follows:

And shall cause such changes and alterations to be made in the dams at Menasha and Appleton, not inconsistent with security to navigation, as may be necessary to reduce and maintain the waters of Lake Winnebago and Little Lake Buttes des Morts, respectively, at their natural height.

The second clause only qualifies the first in so far as it relates to alterations in the Appleton and Menasha dams; it provides for *altering* rather than *removing* the Menasha Dam.

The entire proviso then requires:

(1.) That the Neenah Dam be entirely removed while the Menasha Dam, over the other branch of the river, is to be altered, so far as may be

consistent with security to navigation, so as to reduce to and maintain the waters of Lake Winnebago at its natural height. After the removal of the Neenah Dam, as required by the proviso, it is difficult to see how any changes in the dam at Menasha are to affect the "security of navigation" or the height of the waters of Lake Winnebago.

(2.) The proviso requires the removal of the dam at Neenah and the mills at Menasha that have been built in what was formerly the bed of the river. None of these objects are obstructions to navigation, and their removal would in no way benefit it. The Neenah Dam was built under a charter of the State for water-power purposes, and, being no injury to navigation, the owners would doubtless deny the right of the United States to destroy their property. The removal of all the mills at Menasha that have been built within the river banks as meandered by the land survey would benefit no one, while causing immense damage.

(3.) The proviso requires such alterations to be made in the dam at Menasha as are "not inconsistent with security to navigation, as may be necessary to reduce to and maintain the waters of Lake Winnebago" at its natural height. "Security to navigation" does not require any dam at Menasha, as shown in the report of Colonel Houston, Senate Ex. Doc. No. 53, Forty-seventh Congress, first session. The approved project dispenses with all aid from the Menasha Dam, and the proviso literally interpreted would require, therefore, the reduction of the height of the dam so as not to raise the waters of Lake Winnebago, which would destroy the entire water-power of both Menasha and Neenah.

The Board, considering that the law could not have been designed to cause damage without corresponding benefit, or to interfere with private property which was no damage to navigation, have considered the various steps which led to the passage of the law, in order to arrive at the true meaning and intent of the same.

In the fall of 1881 an extraordinary freshet occurred in the Fox River, doing great damage at Oshkosh, Fond du Lac, and along the Upper Fox and Wolf rivers. The unusual height to which the water rose was attributed largely to the dams at the outlets of Lake Winnebago and Appleton, and an appeal was made to Congress for relief. The following resolutions were passed by the Senate and House of Representatives at this last session of Congress:

IN THE SENATE OF THE UNITED STATES,
December 7, 1881.

Resolved, That the Secretary of War be, and he is hereby, directed to communicate to the Senate all information in his Department as to whether the Government works on the Fox and Wisconsin rivers improvement at Menasha and Appleton, Wis., is the cause of the extremely high stage of water in Lake Winnebago and vicinity, and, if so, how it can be remedied, and what legislation, if any, is necessary to accomplish it.

CONGRESS OF THE UNITED STATES,
IN THE HOUSE OF REPRESENTATIVES,
February 10, 1882.

Resolved, That the Secretary of War be, and he is hereby, directed to inform this House—

First. Whether the dam maintained as a part of the Government works on the Fox and Wisconsin rivers improvement at Menasha, Wis., was not one of the principal agencies in producing a high stage of water in Lake Winnebago during the fall of 1881, whereby great damage was done business property and interest in the cities of Fond du Lac and Oshkosh, situate upon the borders, by overflow of waters from the basin of the lake.

Second. Whether the continuance of said dam at its present height is essential to the improvement of the Fox River, when considered independently of any question of water-power interests belonging exclusively to private parties.

Third. Whether the said dam may not be lowered so as to permit the waters of the lake to discharge in such volume as to prevent a recurrence of the back-water floods of 1881, without impairing the efficiency of the improvement and without causing any radical change in the present adopted plans for the work: and, if it may be so lowered, then that the said secretary shall report to this House to what extent it may be so lowered, together with plans and specifications for the work, and an estimate of the cost thereof.

The reports on these resolutions are published in Senate Ex. Doc. No 53 and House Ex. Doc. No. 93, Forty-seventh Congress, first session. From these resolutions and reports it appears evident that the legislation of Congress had in view the prevention, as far as possible, of the recurrence of extreme high water, and contemplated such alterations in the dams at Menasha and Appleton, and the removal of such obstructions in the channel, as would reduce the height of water during floods.

It appears from the surveys and records that the effect of the dams at the outlets to Lake Winnebago at Menasha and Neenah is to raise the level to the lake so that in time of floods the water rises higher than it would if the dams did not exist, or if they were lower. There are no other dams or obstructions which affect the level of the lake.

To reduce this level so far as the dams are concerned, it is necessary either to remove or lower them, or to make ample sluices in them to be opened as required. Below these dams are rapids; that at Menasha being about 5,000 feet in length, with a fall in ordinary stages from the foot of the dam to the foot of the rapids of about 2 feet 4 inches, the fall over the dam being about 6 feet 4 inches. Below the rapids the river widens to a width of 3,500 feet, forming Little Lake Buttes des Mortes. This lake extends for a distance of 2 miles, when the river narrows for a distance of $2\frac{1}{2}$ miles to the upper dam at Appleton, the minimum width being 400 feet. The effect of the Appleton Dam is to raise the water in the river above, including Little Lake Buttes des Mortes. There are two railroad bridges and three other bridges across the rapids at Menasha, and the channel has been encroached on by mills and mill refuse. Between the foot of the rapids and the Upper Appleton Dam there are two railroad bridges, the Chicago and Northwestern across Little Lake Buttes des Mortes, just below the rapids, and the Milwaukee and Northern a short distance above the Appleton Dam. The effect of these bridges is as follows: The Milwaukee and Northern bridge has a total clear opening between the piers of over 600 feet. The river above being only 400 feet wide, this bridge cannot be considered an obstruction to the flow of water.

Levels taken above and below the bridges show a fall from just above the bridge to the dam of 2 inches.

The Chicago and Northwestern, across Little Lake Buttes des Mortes, has a clear opening of over 1,400 feet. Levels show no fall due to this bridge. The Board is of opinion that the bridges below the Menasha Rapids do not appreciably affect the water level. The total fall in the river from the foot of the rapids to the Upper Appleton Dam, a distance of $4\frac{1}{2}$ miles, at an ordinary stage, is from 6 to 9 inches. Three-fourths of this fall is in the contracted portion of the river just above Appleton, as shown on the profile. This part of the river has been deepened by dredging, which it is proposed to continue, as required for purposes of navigation. The effect of this will be to reduce the fall.

There remains to be considered the effect of the obstructions and en-

croachments on the rapids below the Menasha Dam. These are shown on the accompanying tracing.

The fall in the rapids at Menasha, from the dam to their foot, a distance of about 5,000 feet, is, at ordinary stages, 2 feet 4 inches, the fall at the dam being 6 feet 3 inches. The fall at the dam in the extreme high water of 1881 was over 6 feet. The obstructions and encroachments on the rapids do not affect the heights of either Little Lake Buttes des Morts or Lake Winnebago. They have no influence on navigation, and the only injury they do is to the water-power at Menasha. If the obstructions were removed and the channel widened and deepened, the water would be discharged at a lower level and the water-power be correspondingly benefited. A literal construction of the sentence in the proviso, "to cause the channel of the Lower Fox River, between Lake Winnebago and the Upper Government Dam at Appleton, to be restored to its natural width and capacity," might call for a removal of these obstructions by the United States, but as that would be solely for the benefit of private interests, and would have no influence in the condition of the lake above or the river below, the Board do not understand it to be the intent of the proviso. The Board would recommend, in addition to the recommendations made in its preliminary report, the construction of a sluice-way in the Menasha Dam about 200 feet wide and 3 feet deep.

Private parties at Menasha have commenced the excavation of a canal on the south side of the river from a point above the dam to a point below, to be provided with sluices at the lower end. Should this be done and the canal have sufficient capacity, the sluice-way in the dam will not be necessary.

The attention of the Board is called to the fact that there is no necessity for dams at the outlets of Lake Winnebago for purposes of navigation. It is only necessary to deepen the present canal, or make a new one of the necessary depth from Lake Winnebago to Little Lake Buttes des Morts, as recommended by Colonel Houston in his report. (See House Ex. Doc. No. 93, Forty-seventh Congress, first session.) The same objects can be accomplished more economically and with better results by deepening the channel and the old canal at Neenah, which was formerly used for purposes of navigation, but which was abandoned when the canal at Menasha was opened. This canal was constructed under an act of the Territorial legislature of Wisconsin, which is still in force as far as relates to that canal.

The route at Neenah possesses the following advantages over that at Menasha, viz: The canal is only about 1,200 feet long, while that at Menasha is 4,000 feet; it is straight, while that at Menasha makes an angle, obstructing the view; there is an independent water-power canal to supply the mills, while the mills at Menasha draw their water direct from the canal for navigation, creating currents and lowering the water; there are no obstructions by logs, &c., in the canal, as is the case at Menasha; the channel in the river above the canal can be deepened to the required depth by dredging, while a large amount of rock excavation is necessary at Menasha.

The number of bridges is the same. A draw will also be necessary in the Chicago and Northwestern Railroad across Little Lake Buttes des Morts, which can be located so as to be no obstruction to navigation.

The Board would respectfully call attention to the fact that it is claimed by parties interested in the water-power at Menasha that the alterations recommended to be made in the Menasha dam will seriously injure them, and that compensation should be made for such injury. This

involves legal questions as to the right of the Government to make the changes proposed, which is a matter to be considered by the law department of the Government.

The Board have simply recommended in this and the preliminary report what it believes to be necessary to carry out the intent of the law.

Respectfully submitted.

D. C. HOUSTON,
Lieut. Col. Engineers, Bvt. Col.
HENRY M. ROBERT,
Major of Engineers.
W. H. H. BENYAUBD,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., November 14, 1882.

SIR: I have the honor to submit herewith an additional and final report from the Board of Engineer officers constituted to take into consideration and report upon the conditions attached to the appropriation of August 2, 1882, for the improvement of Fox and Wisconsin rivers, requiring certain changes to be made in the dams at Menasha and Appleton, in order to maintain the waters about the outlet of Lake Winnebago to their natural heights.

The preliminary report submitted September 9 recommended, in order to obtain immediate relief from possible disaster from floods, that the lowering of these two dams be at once proceeded with. This recommendation met with your approval, and the work which has been delayed by an injunction to arrest it is now reported to be in progress, the legal proceedings having been discontinued at the instance of the plaintiffs.

In the present report the Board assumes that in this legislation Congress had solely in view the prevention, as far as possible, of the recurrence of extreme high water, and contemplated only such alterations in the dams at Menasha and Appleton, and the removal of such obstructions in the channel as would reduce the height of water during floods; and to this end the Board recommended, in addition to its former recommendations, the construction of a sluice-way in the Menasha Dam about 200 feet wide and 3 feet deep, with the remark that should the canal on the south side of the river, from a point above the dam to a point below, the construction of which has been commenced by private parties, be provided with sluices and have sufficient capacity, the sluice-way in the dam will not be necessary; and further suggests that, for the purposes of navigation, it would be better to deepen the channel and the old canal at Neenah than to deepen the canal or make a new one at Menasha.

In concurring with the views and recommendations of the Board, I would respectfully call attention to the very clear explanation given in this report of the reasons which led to their adoption; which recommendations the Board believes to be necessary to carry out the intent of the law; and also to the statement that it is claimed by parties interested in the water-power at Menasha that the proposed alterations in

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the Menasha dam will seriously injure them, and that compensation should be made for such injury.

Should, therefore, these recommendations meet with your approval, the legal question as to the right of the Government to make the changes proposed would have to be taken into consideration.

The preliminary report of the Board is herewith.

Very respectfully, your obedient servant,

H. G. WRIGHT,
*Chief of Engineers,
Brig. and Bvt. Maj. Gen.*

Hon. ROBERT T. LINCOLN,
Secretary of War.

[First indorsement.]

Respectfully returned to the Chief of Engineers.

The Secretary of War thinks that further information should be obtained as to the probability of the construction by private parties of the canal within mentioned before taking any action on these papers.

ROBERT T. LINCOLN,
Secretary of War.

WAR DEPARTMENT, November 21, 1882.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY, December 29, 1882.

Respectfully returned to the honorable the Secretary of War, submitting, in reply to the above indorsement, the accompanying letter to this office of December 16, 1882, from Lieut. Col. D. C. Houston, Corps of Engineers. It will be perceived that it does not appear to be the intention of private parties to construct the canal in question around the south end of the Menasha Dam. The work of lowering the old dam at Menasha, recommended by the Board in its first report as a preliminary measure, has again been arrested by an order of the local court, and the case has been transferred to the United States court, the next term of which is in January next. It is submitted whether the United States district attorney might not be instructed to take this opportunity to test the question as to the right of the Government to make the changes in this dam proposed in the final report of the Board.

H. G. WRIGHT,
*Chief of Engineers,
Brig. and Bvt. Maj. Gen.*

LETTER OF LIEUTENANT-COLONEL D. C. HOUSTON, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., December 16, 1882.

GENERAL: I have the honor to report, in reply to your letter of November 24, 1882, that on the 4th instant I addressed a letter to Mr. P. V. Lawson, of Menasha, Wis., representing the water-power interest, who commenced, last fall, the construction of a canal around the south end of the dam at Menasha, as follows:

SIR: Your letter of November 26, 1882, was found by me on my return here yesterday.

The Board of Engineers in its last report, dated October 30, 1882, recommended, "in addition to the recommendations made in its preliminary report, the construc-

tion of a sluice-way in the Menasha Dam, about 200 feet wide and 3 feet deep," and stated "that private parties at Menasha have commenced the excavation of a canal on the south side of the river, from a point above the dam to a point below, to be provided with sluices at the lower end. Should this be done and the canal have sufficient capacity, a sluice-way in the dam will not be necessary." I have received a communication from the Chief of Engineers with the following indorsement of the War Department:

"Respectfully returned to the Chief of Engineers.

"The Secretary of War thinks that further information should be obtained as to the probability of the construction by private parties of the canal within mentioned before taking any action on these papers.

"ROBERT T. LINCOLN,
"Secretary of War."

Will you please inform me whether it is your intention to construct a canal around the south end of the Menasha Dam, and, if so, the dimensions of the same, width, depth below low water, length, and dimensions of sluice-way at lower end of dam.

If it is proposed to make such canal, when will it be done, and what guarantee can you give that it will be done?

Your statement that you have not consented to allow any interference with the dam at Menasha, and that you have owned that property, and still own it, will be forwarded to the Chief of Engineers.

In reply to your letter to Colonel Fuller of November 28, 1882, I would state that we have soundings of the canal at Menasha, made in 1873 by Mr. Russell, who is not now employed on the work, and whose address is not in this office.

Very respectfully, your obedient servant,

D. C. HOUSTON,
Lieut. Col. of Engineers,
Bvt. Col., U. S. A.

P. V. LAWSON, Esq.,
Menasha, Wis.

I have received no reply to this communication. The letter from Mr. Lawson to which I refer is as follows:

MENASHA, WIS., November 26, 1882.

DEAR SIR: Has anything further been decided on in the matter of lowering, reconstructing, or improving our dam here at Menasha? I am informed that it is the present intention of the Department to lower that portion of the dam which lies between the coral mill and paper mill to a depth of 3 feet, as originally intended. Is this so?

I am also informed that that improvement is to hinge on the condition that we open up the contemplated sluice-way in the Lawson Canal south of the paper mill; in other words, if one is constructed the other will not be. Is there any truth in this?

I beg to inform the Department again that we have not consented, nor do we consent, to any interference by the Government with the dam here, and that we have owned that property, and still own it, and that any interference with the same is a trespass on our rights and upon our property.

The present uncertain condition of things has been a great set back to improvements and investment this winter, and if anything can be done to put a final settlement to all matters and contemplated improvements at once and some guarantee given for the future, we hope the Department can see its way clear to do so.

Yours, very truly,

P. V. LAWSON.

Col. D. C. HOUSTON.

The recommendations of the Board of Engineers constituted by Special Orders No. 81, headquarters Corps of Engineers, current series, in their preliminary report dated September 1, 1882, and approved by your letter of September 21, 1882, have been carried out as far as the lateness of the season and interruption by legal proceedings would permit.

The old dam proper has been lowered 18 inches and flush-boards (removable) 18 inches high placed thereon. Excavation has been made and timbers partially framed to extend the dam to the railroad track at Syme's mill, preparatory to removing the embankment, but this work has been suspended by another order of the circuit court of Winnebago County, Wisconsin, dated December 2, 1882, on petition of Alex Syme, owner of mills adjacent to the dam. The case was heard on the 9th

instant, the United States being represented by Hon. O. B. Thomas, special Assistant Attorney-General, and the case is transferred to the United States circuit court for the eastern district of Wisconsin, the next term of which is in January next.

I do not think it is the present intention of private parties to construct a canal around the south end of the dam.

In lowering the old dam it was found to be in very poor condition, so much so that it should be rebuilt as soon as practicable. The rebuilding will necessitate a coffer-dam above, as indicated on the accompanying tracing. The tracing shows the form of sluice-way it is proposed to construct.

There will be 27 openings, each 5 feet wide and 4 feet high, which will discharge a volume of water equivalent to an opening 200 feet long and 3 feet deep. The sluice-way will not cost as much as a fixed dam, and from the manner in which it is proposed to construct it, will be as effective for all purposes, and admit of being opened at any time. The openings are closed by gates which are practically water-tight.

I am, general, very respectfully, your obedient servant,

D. C. HOUSTON,
Lieut. Col. of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

LETTER OF THE HON. THE SECRETARY OF WAR TO THE HON. THE
ATTORNEY-GENERAL.

WAR DEPARTMENT,
Washington City, January 2, 1883.

SIR: I have the honor to inclose herewith, with other papers on the subject, a communication from the Chief of Engineers, dated November 14, 1882, submitting to this Department the final report from the Board of Engineer officers constituted to take into consideration and report upon the conditions attached to the appropriation of August 2, 1882, for the improvement of Fox and Wisconsin rivers, requiring certain changes to be made in the dams at Menasha and Appleton, in order to maintain the waters about the outlet of Lake Winnebago to their natural heights.

It appearing from said report that the construction of a canal on the south side of the river from a point above the dam to a point below had been commenced by private parties, the papers, as will be seen by indorsement on the above-mentioned letter, were returned to the Chief of Engineers with statement that further information should be obtained as to the probability of the construction, by private parties, of the canal referred to before taking action in the matter, and have been returned by the Chief of Engineers, inclosing additional papers, from which it appears not to be the intention of private parties to construct the canal in question.

It appears, however, that certain work recommended by the Board in its report as a preliminary measure has again been arrested by an order of the local court, and that the case has been transferred to the United States court, the next term of which is in January instant, and the Chief of Engineers submits whether it is not advisable to take this opportunity to test the question as to the right of the Government to make the changes in the dam proposed in the final report of the Board.

In view of the questions presented I beg that, should such course be

deemed advisable, you will please instruct the proper United States district attorney to examine into the questions involved, and to take such measures as may be deemed proper to protect and maintain the rights of the United States in the premises.

Very respectfully, your obedient servant,

ROBERT T. LINCOLN,
Secretary of War.

The honorable the ATTORNEY-GENERAL.

LETTER OF MR. N. M. EDWARDS, CIVIL ENGINEER.

APPLETON, WIS., *March 23, 1883.*

DEAR SIR: In answer to your request for an estimate of the cost of a plan of deep sluice-ways near one end of the Appleton stone dam, with gates thereto, as compared with the present requirements of the War Department, and also for results of calculations upon the effectiveness of each method, I would reply:

I understand the War Department proposes to lower the dam 18 inches by removing the heavy, finely-finished cut-stone work which is now thoroughly clamped and doweled, forming the top of the dam, and upon the less compact stone masonry to place wood work and adjustable gates or flush-boards along the whole length of the dam.

My estimate of the cost of removing the 696 feet of the top surface for the flow of water is about \$5,000.

Gates for over the whole length of the dam that may be readily worked, say \$3,000.

The other plan suggested is as follows: To cut three openings, of 20 feet each, down to the bed-rock of river, near the southeast end of the dam, within the part already inclosed by coffer-dam and where the top is already removed, leaving but about a space of 10 feet for piers between the openings. The piers to be about 30 feet long, 10 wide, and about 13 high. The openings or sluice-ways to have gates readily worked, to allow unobstructed flow of water or any proportion thereof.

The Taintor gate I would advise as the best adapted of any within my knowledge to answer the purposes required, a rough side view of which is given on the plan herewith.

The work already done, in removing top of the dam, will not be lost, as the location is adapted for sluice-ways, thus throwing a large volume of water toward the middle of the river, correcting a tendency to excess of water flow during a freshet on the north side.

My estimate of the cost of said piers, together with the removing of the parts of the dam and completing the masonry ready for the gates is \$3,400.

For cost of gates, attachments for working and securing same in position, \$1,500.

Upon the accompanying plan will be seen a sketch of the location and plan suggested.

After lowering the dam 18 inches, having a top with greater resistance than the present form to the flow of water, I calculate that 4 feet flow over the dam will give about 1,120,000 cubic feet flow per minute, or about the same as passed over at the time of the greatest flood ever experienced in Appleton.

Now, with the newly-suggested plan of three openings, each 20 feet wide, extending to the bed rock and having gates that can be readily worked by one man, allowing full flow or any part thereof, together

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with the flow over the remaining 608 feet of the present form of dam, by calculation, I get a total flow of 1,270,000 cubic feet per minute; if a greater flow is demanded another gateway can be readily added now or at any future time.

Respectfully, yours,

N. M. EDWARDS,
Civil Engineer.

Hon. A. L. SMITH.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
April 10, 1883.

Respectfully returned to the honorable the Secretary of War.

The act of August 2, 1882, provides that the Secretary of War shall cause such changes to be made in the dam at Appleton not inconsistent with the security of navigation, as may be necessary to reduce to and maintain the waters of Lake Winnebago and Little Buttes des Morts, respectively, at their natural height.

The Hon. Messrs. Smith and Guenther, and others, prefer that the changes and alterations at upper dam at Appleton should consist in a sluice-way, either extending to the entire depth of the dam to the natural rock upon which it is founded, as shown in the drawing submitted with these papers, or, as they state in conversation, by an equivalent sluice of less depth, while the Board to which this subject was referred recommended the removal of the top of the dam to the depth of 18 inches, and the use of flush-boards during the seasons of low water.

Either of the modes suggested will, in my judgment, comply with the requirements of the law, and I have recommended that the one advised by the Board be adopted. While I do not see that the choice between these is very important, yet the Board which visited the locality may have been influenced by considerations which are not apparent to us here.

In view of the wishes of the people representing the local interests, and the idea presented by Mr. Smith, that the Board was influenced in its choice by what it deemed the requirements of the law, it seems to me proper that the Board be again called together to reconsider the subject.

If this suggestion be approved, the necessary orders will be issued by this office.

It should be stated that the report of the Board was sent to the Department of Justice and transmitted thence to the United States attorney in Wisconsin, with other papers in connection with the injunction proceedings in the case of the Menasha Dam. It cannot, therefore, be submitted with these papers.

H. G. WRIGHT.
*Chief of Engineers,
Brig. and Bvt. Maj. Gen.*

[Second indorsement.]

Respectfully returned to the Chief of Engineers approving his suggestion that the Board be again called together to reconsider the subject.

By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

WAR DEPARTMENT, April 11, 1883.

LETTER TRANSMITTING REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., May 10, 1883.

GENERAL: I have the honor to transmit herewith the report of the Board of Engineer officers reconvened by Special Orders No. 40, dated Headquarters Corps of Engineers, Washington, D. C., April 14, 1883, and to return the papers sent with your letter of instructions dated April 14, 1883.

I am, general, very respectfully, your obedient servant,
 D. C. HOUSTON,
Lieut. Col. of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
 U. S. ARMY,
May 12, 1883.

Respectfully submitted to the honorable the Secretary of War.

The Board of Engineers was reconvened at Appleton, Wis., by direction of the Secretary of War "for the purpose of considering and reporting upon certain protests of citizens against the lowering of the upper dam at Appleton," &c., and its report is just received at this office.

It will be seen that the Board approves the general plan proposed by Mr. N. M. Edwards, civil engineer, submitted to the War Department April 10, 1883, by the Hon. E. Guenther and the Hon. A. L. Smith, and recommends the cutting of "four openings, each 20 feet long, down to the bed rock upon which the dam rests, near the south end of the dam where the top is already removed, leaving a space between the openings for piers to support gates which can be easily raised or lowered to allow an unobstructed or partial flow of water as required. From the information before the Board, the Taintor gate recommended by Mr. Edwards seems the best adapted for the purpose.

"The number of openings may be increased in future if found necessary."

I concur in the views and recommendations of the Board, believing that the plan now recommended will answer the purpose as well as the lowering of the dam heretofore recommended, and will better meet the views and wishes of those interested at Appleton.

Previous papers herewith.

H. G. WRIGHT,
*Chief of Engineers,
 Brig. and Bot. Maj. Gen.*

[Second indorsement.]

The Secretary of War concurs with the Chief of Engineers in the views and recommendations of the Board of Engineers.

By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

WAR DEPARTMENT, *May 15, 1883.*

REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., May 10, 1883.

GENERAL: The Board of Engineers constituted by Special Orders No. 81, Headquarters Corps of Engineers, series of 1882, and reconvened by Special Orders No. 40, dated Headquarters Corps of Engineers, Washington, D. C., April 14, 1883, having met at Appleton on the 9th instant, has the honor to submit the following report:

The proviso in the river and harbor act approved August 2, 1882, relating to the Fox and Wisconsin rivers, requires—

Such changes and alterations to be made in the dams at Menasha and Appleton, not inconsistent with security to navigation, as may be necessary to reduce to and maintain the waters of Lake Winnebago and Little Lake Buttes des Morts, respectively, at their natural height.

In its preliminary report, dated September 1, 1882, the Board recommended—

That the dam at Menasha and the upper Government dam at Appleton be lowered 18 inches below the crests, and that provision be made to *raise* the dams in low water by appliances which can readily be removed and which shall be subject to the control of the Government. The dams will be in part movable.

The lowering of the dams was for the purpose of reducing the height of the water in Lake Winnebago and Little Lake Buttes des Morts, and provision was made for *raising* the dams by movable arrangements in low water, should it be necessary for purposes of navigation.

This plan seemed to the Board to conform as nearly as possible to the intent of the law, and it was understood that the lowering of the dams was demanded by those directly interested in reducing the height of water in the lakes.

As the Appleton Dam bears the same relation to Little Lake Buttes des Morts that the Menasha Dam does to Lake Winnebago, the same plan was recommended in both cases. In the final report of the Board, dated October 30, 1882, no further recommendation was made in reference to the Appleton Dam. The Appleton Dam is of solid stone masonry, 700 feet long, capped with heavy coping-stone 19 inches thick; 150 linear feet of this coping have been removed, and, under the present plan, are to be replaced by plank supported by iron brackets. The brackets are hinged so that when the plank are removed they will lie flat on the top of the dam. The plank are to be 14 feet long, 11 inches wide, and 2 inches thick, so that they can be readily handled. Similar arrangements have been in use at other points for many years.

The citizens of Appleton and some persons directly interested in navigation object to this plan for the reasons (more fully stated in the accompanying papers) that the boards are liable to be displaced by floating logs and ice, and that it will be difficult and take a long time to replace them, thereby injuring the water power at Appleton and interfering with the navigation of the river.

They therefore ask that, instead of lowering the dam, sluice-ways be substituted; and a plan for such sluice-ways has been submitted to the War Department and referred to this Board.

The present plan, like most movable dams in similar localities, is open to the objections made, though it is believed they are not so serious as supposed.

The water in Little Lake Buttes des Morts can be lowered by means of sluice-ways of sufficient capacity in the Appleton Dam as well as by

the plan recommended by the Board, and it appears from the indorsement of the Chief of Engineers, dated April 10, 1883, that this method will comply with the requirements of the law.

In view of this, and for the reason that it will meet the views of the citizens of Appleton and those interested in navigation, without detriment to other interests, the Board would recommend that sluices be made in the upper Appleton dam of such capacity that, when opened, the height of water may be reduced at least as much as by lowering the entire dam 18 inches.

The Board approves the general plan proposed by Mr. N. M. Edwards, civil engineer, submitted to the War Department by Hon. R. Guenther and Hon. A. L. Smith, April 10, 1883. The plan recommended is as follows: To cut four openings, each 20 feet long, down to the bed rock upon which the dam rests, near the south end of the dam, where the top is already removed, leaving a space between the openings for piers to support gates which can be easily raised or lowered to allow an unobstructed or partial flow of water as required. From the information before the Board, the Taintor gate, recommended by Mr. Edwards, seems the best adapted for the purpose.

The number of openings may be increased in future if found necessary.

The Board has considered the protest against this change of plan by Mr. J. L. Clement, chairman of the Neenah Water Power Company, submitted to the Chief of Engineers by Mr. J. R. Davis, April 10, 1883, and it appears from an interview with the parties interested, both at Neenah and Appleton, that the objection is not so much to the sluices as to the possibility that they may not be so operated as to lower the water with the same certainty as would result from a permanent lowering of the dam 18 inches.

This objection is disposed of by the fact that the dam is the property of the United States and the gates under control of its officers.

It was proposed by those interested at Neenah that the sluices should be kept open as long as the water was above the crest of the dam. Those interested in the water-power at Appleton think that the head on the dam should not be less than 8 inches when the volume of discharge is sufficient.

This latter question is one that does not affect the navigation of the river, but is purely a matter affecting the local and manufacturing interests at the two places. As the head of water on the dam at Appleton, which will not injure the water-power at Neenah, is a variable quantity, depending upon the available head of water at the Neenah Mills, the Board does not deem it advisable to fix it absolutely, and is of opinion that the matter should be determined by agreement between the parties interested, whose interests seem to be in conflict.

Respectfully submitted.

D. C. HOUSTON,
Lieut. Col. Engrs., Bvt. Col.
HENRY M. ROBERT,
Lieut. Col. Engrs.
W. H. H. BENYAURD,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

APPENDIX G G.

IMPROVEMENT OF THE HARBORS OF CHICAGO AND CALUMET, LAKE MICHIGAN—IMPROVEMENT OF ILLINOIS RIVER—SURVEYS FOR HENNEPIN CANAL, AND FOR THE ENLARGEMENT OF THE ILLINOIS AND MICHIGAN CANAL.

REPORT OF MAJOR W. H. H. BENYAURD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|------------------------------|--------------------|
| 1. Chicago Harbor, Illinois. | 3. Illinois River. |
| 2. Calumet Harbor, Illinois. | |

SURVEY.

4. For Hennepin Canal, and for the enlargement of the Illinois and Michigan Canal.
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UNITED STATES ENGINEER OFFICE,
Chicago, Ill., July 25, 1883.

GENERAL: I have the honor to transmit herewith annual reports of operations upon works of river and harbor improvement under my charge for the fiscal year ending June 30, 1883.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

G G I.

IMPROVEMENT OF HARBOR AT CHICAGO, ILLINOIS.

The project of improvement now in course of execution at this harbor was adopted in 1870 and modified in 1878. The objects sought are, *first*, the formation of an outer harbor adjoining the entrance to the Chicago River, and designed also to furnish increased commercial facilities, by relieving the river from its overcrowded condition; *second*, the creation of a harbor of refuge, affording a good anchorage in deep water and safe access to the outer harbor and river.

EXTERIOR BREAKWATER.

The first crib for this breakwater was sunk in position July 7, 1881, and by the end of that fiscal year 1,536 linear feet of cribs were sunk, and superstructure to the required height placed over about 1,200 feet.

The appropriations for this work became exhausted July 5, 1882, and the work was then suspended, and was not resumed until August 17, after the appropriation of August 2 had become available.

Six weeks of the most advantageous working season were lost thereby.

At the close of the working season of 1882, eight additional cribs of 100 feet each had been sunk, and superstructure to the height of 4 feet placed over the entire length.

Active operations, under the supervision of Mr. George C. Almy, were resumed on April 24, last, and at the close of the fiscal year one additional crib of 100 feet in length was sunk, two more were ready for sinking, and three others were in various stages of completion.

In addition, other miscellaneous work was done in the way of building scows and repairing the breakwater, damaged by storms and collisions.

The breakwater was struck several times and somewhat damaged by inward and outward bound craft during the season, as follows:

August 6, by steamer *Siberia*, breaking thirteen courses of timber below the water. September 20, by unknown vessel, breaking eleven courses of timber below the water. October 12, by unknown vessel, at two points, breaking four courses of timber below the water and carrying away the lamp-post from Crib No. 12. December 2, by schooner *Floretta*, loosening about 75 feet of superstructure.

On May 20 and 21, during a very severe northeast storm, some vessels in attempting to enter the harbor ran afoul of the breakwater, and one section of the superstructure, about 200 feet long, and several courses of the work below the water level were carried away and landed near Fifty-first street. On the 31st of the same month the schooner *Regulator*, outward bound, ran into the breakwater, but did very little damage to the work.

Advertisements inviting proposals for 2, 225,000 feet, B. M., timber for breakwater construction were published December 5, 1882, and opened January 10, 1883, and contracts awarded as follows:

Alfred S. Packard, hemlock timber for five cribs, at \$12.50 per thousand; pine timber for five cribs, at \$17 per thousand.

A. H. Petrie & Co., hemlock timber for five cribs, at \$11.25 per thousand; pine timber for five cribs, at \$15.45 per thousand.

An agreement was entered into with Singer & Talcott Stone Company for some 6,000 cords of stone, at \$5.25 per cord, being a reduction of 75 cents per cord from the price paid last year.

The contract with George Hannahs, dated March 24, 1881, for furnishing timber for this harbor was annulled July 22 by authority from the Chief of Engineers in letter dated July 18, leaving undelivered 611,192 feet, B. M., of the amount contracted for.

DREDGING IN OUTER HARBOR.

The present project contemplates dredging the outer harbor to a depth of 16 feet, the westerly limit of dredging being the dock line established by the Board of Engineers, convened by Special Order 168, Chief of Engineers, August 3, 1871, the area included being about two hundred

and seventy acres, the original depth of which varied from 10 to 19 feet. The remainder of the sheltered area will be reserved for piers and slips, and comprises one hundred and eighty-five acres, making the total lake area included within the limits of the outer harbor four hundred and fifty-five acres.

There was no dredging done during the year.

In response to advertisements for proposals for dredging dated December 5, 1882, bids were received and opened January 10, 1883, but all were rejected as being considered unreasonably high, the lowest bid being that of Harry Fox & Co., 24½ cents per cubic yard.

This work was re-advertised and bids received and opened May 30, and contracts awarded to Green Bay Dredge and Pile-Driver Company at 17½ cents per cubic yard, being 6¾ cents per yard less than any bid at the previous opening.

A survey of the harbor was made by Mr. G. A. M. Liljencrantz, assistant engineer, so as to ascertain its present condition, and give full information as to the amount of dredging required.

The result of the survey shows that there has been a deposit varying in amount, and reaching a maximum of about 18 inches in the northerly portion of the area dredged since 1879, and to a slight extent at certain points in the middle and southerly portions of this area. The shallowest of these places is directly inside of the entrance to the basin from the river, and in direct line of vessels entering at that point. These various points will receive attention at the outset of the dredging operations. The total amount of material yet to be removed from the harbor amounts to about 400,000 cubic yards.

PROPOSED APPLICATION OF FUNDS AVAILABLE.

The amount available for the coming season, exclusive of outstanding liabilities is \$45,651.40.

It is proposed to continue dredging operations in the harbor to the extent of removing 118,000 cubic yards of material. Work will also be continued upon the construction of the exterior breakwater, and it is estimated that at the end of the fiscal year ending June 30, 1884, 3,400 feet of crib work will have been completed, with the superstructure to a full height over about 3,000 feet.

ESTIMATE FOR THE YEAR ENDING JUNE 30, 1885.

For the purpose of continuing the extension of the exterior breakwater, the sum of \$200,000 is asked, being the same amount estimated for, but not appropriated last year. The work of deepening the outer harbor should also be continued, which will require \$30,000 additional for the next season's work.

The estimated cost of the contemplated improvement is \$1,009,500. This includes the cost of the southerly breakwater (since completed), the dredging of the outer harbor, and the completion of the exterior breakwater.

The total amount applicable to these works since the project was adopted is \$625,500, made up as follows:

Amount available when project was adopted.....	\$55,500
Appropriated March 3, 1879	75,000
Appropriated June 14, 1880	145,000
Appropriated March 3, 1881	150,000
Appropriated August 2, 1882	200,000
Total	625,500

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Of this amount there has been expended to the 30th of June, 1883 (including outstanding liabilities), \$579,848.60.

Chicago is a port of entry in the collection district of Chicago. There is a light-house on the shore end, and a beacon light on the lake end of the north pier; there is also a beacon light on the south end of the westerly breakwater.

Number of vessels entered during the fiscal year	12, 048
Number of vessels cleared during the fiscal year	12, 845
Amount of revenue collected	\$4, 169, 112 52

Money statement.

July 1, 1882, amount available	\$41, 852 55
Amount appropriated by act passed August 2, 1882	200, 000 00

241, 852 55

July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$130, 843 85
July 1, 1883, outstanding liabilities	65, 357 30
	<u>196, 201 15</u>

July 1, 1883, amount available	45, 651 40
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Amount (estimated) required for completion of existing project	384, 000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	230, 000 00

Abstract of proposals received and opened January 10, 1883, for furnishing 2,255,000 feet, B. M., timber, for breakwater construction, at Chicago, Ill.

No.	Name of bidders.	Substructure.		No. of cribs.	Superstructure.		Total for one crib.		Total for ten cribs.	
		Pine.	Hem-lock.		Pine.	No. of cribs.	All pine.	All hem-lock.	All pine.	All hem-lock.
		<i>Per M.</i>	<i>Per M.</i>		<i>Per M.</i>					
1	Albert H. Petrie and William McMillen*	\$11 25	5	\$15 45	5	\$2 718 29			\$27, 182 90	
2	Alfred S. Packard†	12 50	7	17 00	7	3, 011 11			30, 111 10	
3	Peter Fesh	14 45	4	17 90	4	3, 383 96			33, 839 00	
4	Patrick Would	\$18 45	14 45	4	18 45	4	\$4, 077 09	3, 414 37	\$40, 770 90	34, 143 78
5	Archibald McArthur	20 75	18 75	10	22 75	10	4, 695 95	4, 364 59	46, 959 50	43, 645 00
6	Bickford, Knox & Co.	18 20	14 40	10	18 20	10	4, 021 85	3, 392 27	40, 218 50	33, 922 70
7	George Hannaha	12 90	10	18 50	5	3, 160 83			31, 603 30	
8	Fitzsimmons & Connell	18 50		5	18 50	10	4, 088 15		40, 881 50	

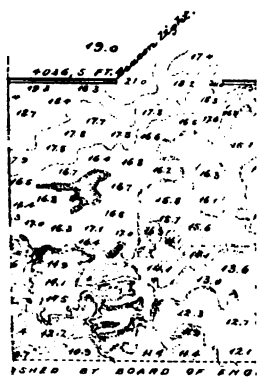
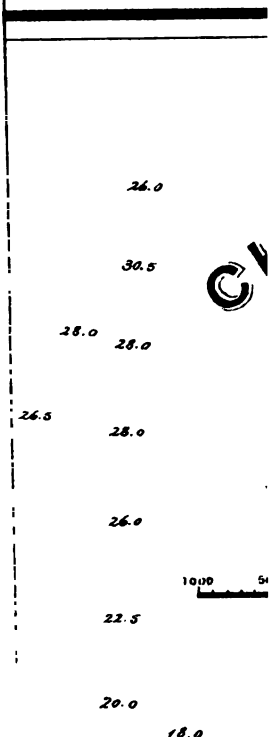
* Awarded.

† Five cribs awarded.

Abstract of proposals received and opened January 10, 1883, for dredging Chicago Harbor, Illinois.

No.	Names of bidders.	Price.
		<i>Per cu. yd.</i>
1	Harry Fox & Co	\$0 24
2	Chicago Dredging and Dock Company	25
3	Green's Dredging Company	25
4	F. M. Knapp	25
5	Carkin, Stickney & Cram	26
6	Truman & Cooper	27

NOTE.—All rejected.



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Abstract of proposals received and opened May 30, 1883, for dredging Chicago Harbor, Illinois.

No.	Names of bidders.	Price.
		<i>Per cu. yd.</i>
1	Harry Fox & Co.....	\$0 21½
2	Green's Dredging Company.....	24½
3	Chicago Dredging and Dock Company.....	23
4	Carkin, Stickney & Cram.....	27
5	Green Bay Dredge and Pile-Driver Company*.....	17½

* Contract awarded.

Abstracts of contracts for Chicago Harbor, Illinois, in force during the fiscal year ending June 30, 1883.

Contractors.	For—	Date of contract.	Expiration of contract.	Remarks.
George Hannahs.....	Timber.....	Mar. 24, 1881	October 1, 1881	Extended to June 30, 1882, and annulled July 22, 1882.
William E. Hutchinson.....	do.....	Apr. 19, 1882	September 1, 1882	Completed.
George Hannahs.....	do.....	Apr. 19, 1882	September 1, 1882	Do.
Bickford, Knox & Co.....	do.....	Apr. 14, 1882	September 1, 1882	Do.
A. H. Petrie & Co.....	do.....	Jan. 30, 1883	September 1, 1883	
Alfred S. Packard.....	do.....	Jan. 27, 1883		
Green Bay Dredge and Pile- Driver Company.	Dredging.....	June 21, 1883	Close of season of navigation of 1883.	
Singer and Talcott Stone Company.	Stone.....	Apr. 21, 1883		

G G 2.

IMPROVEMENT OF HARBOR AT CALUMET, ILLINOIS.

The object of this improvement is to provide a safe and reliable entrance to the Calumet River and port of South Chicago. This is to be accomplished by the construction of two parallel piers 300 feet apart, projecting from the shore to deep water in the lake, and by dredging the channel-way between them to a depth sufficient to accommodate the largest class of vessels. This work was commenced in 1870, and the total length of pier work completed is 4,860 linear feet; of which 3,340 feet belong to the north pier, and 1,520 feet belong to the south pier.

The appropriation of August 2 last became available too late to make any preparations for active work before the winter season. Advertisements inviting proposals for dredging 25,000 cubic yards, more or less, in the harbor, and for extending the north pier 300 additional linear feet, were published November 10, and opened December 21, 1882, and contracts awarded as follows:

Calumet and Chicago Canal and Dock Company for dredging; and Messrs. Walsh & Hannahs, of South Chicago, for pier extension.

Work was commenced under these contracts on the 1st of May, but during the interval between that date and the close of the fiscal year, June 30, the weather was more or less unfavorable for outside work. At the latter date 11,007 cubic yards of material had been dredged from the harbor, and Messrs. Walsh & Hannahs had two cribs, each 100 feet long, for the pier extension, nearly completed, and all the piles driven for the pier foundation.

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In connection with the improvement of Calumet Harbor, the river and harbor act of August 2 last contained a provision directing the appointment of a Board of Engineer officers to report upon certain matters in connection with the improvement of the Calumet River. The Board convened at Chicago October 3, 1882, and the report was forwarded to the Chief of Engineers October 6.

CONDITION OF THE WORK JUNE 30, 1883.

The crib work in both piers is in comparatively good condition, but for the proper security of the work it will be necessary to partially refill some of the cribs, as the stone has settled below the water level. From an inspection made last month it is estimated that about 200 cords of stone will be required for the north pier.

The shore line north of the harbor has advanced somewhat during the past season, due almost entirely to the dumping of slag into the lake by the proprietors of the rolling mill.

The recession of the shore line south of the harbor continued during the past season. At the close of the last fiscal year it was noted that the lake had, at several points, broken through the narrow strip of land that formerly existed between the lake and the old river outlet. This strip is now entirely gone, and allows the sea to flow around the land end of the south pier into the river channel, and tends to fill the same up with sand. The Calumet Land and Dock Company propose to fill up this gap and build a line of revetment out on the original shore line and fill up the intervening space. If this were not done, the Government, in order to protect the work already accomplished, would have to build a line of revetment extending from the land end of the south pier to the nearest point of the shore opposite, a distance of 650 feet.

The contract of Messrs. Walsh & Hannahs was extended to July 31, and that of the Calumet and Chicago Canal and Dock Company to August 31.

PROPOSED APPLICATION OF FUNDS AVAILABLE.

The amount available July 1, 1883, was \$30,659.11, including outstanding liabilities. This will be exhausted in completing the contracts now in force for dredging and for pier extension. The entire amount will be exhausted in the course of the present season.

ESTIMATE OF FUNDS FOR YEAR ENDING JUNE 30, 1885.

In my annual report for last year I estimated for a further extension of the south pier, a distance of 500 feet, in order to procure a permanent channel depth at that point, also to repair the old pile revetment. It is further proposed to fill the cribs of the north pier with stone to the water level, as before mentioned.

The cost of the work is as follows:

Extension of the south pier 500 feet, at \$60 per foot.....	\$30,000
Sheet piling on inner end of north pier 730 feet, at \$8 per foot.....	5,840
200 cords of stone, at \$9 per cord	1,800
Contingencies, superintendence, repairs, office expenses, &c.....	3,760
Total	41,400

The dredging estimated for last year will not be asked for until the pier extension recommended is carried out and the effects of the work ascertained.

Up to June 30, 1883, there had been appropriated \$362,000, of which \$331,340.89 have been expended; the total length of piers built is 4,860 feet, and the total amount of dredging done is 361,990 cubic yards.

The harbor of Calumet is at South Chicago, in the collection district of Chicago. There is a light-house and a keeper's dwelling on the reservation near the shore end of the north pier. A beacon light is maintained at the extremity of that pier to mark the entrance to the harbor.

Number of vessels entered during the fiscal year.....	407
Number of vessels cleared during the fiscal year.....	414
Total tonnage of vessels entered and cleared.....	440, 999

Money statement.

July 1, 1882, amount available.....	\$1, 013 45
Amount appropriated by act passed August 2, 1882.....	35, 000 00
	<hr/> 36, 013 45

July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$5, 354 34
July 1, 1883, outstanding liabilities.....	24, 286 73
	<hr/> 29, 641 07

July 1, 1883, amount available.....	<hr/> 6, 372 38
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Amount (estimated) required for completion of existing project.....	41, 400 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	41, 400 00

Abstract of proposals received and opened December 21, 1882, for furnishing material and labor, improving harbor at Calumet, Ill.

No.	Names of bidders.	Pine timber.	Hemlock timber.	Pine-piles.	Drift-bolts.	Screw-bolts.	Spikes.	Stone.	Total for 100 feet of work.	Total for 800 feet of work.
		<i>Per M.</i>	<i>Per M.</i>	<i>Each.</i>	<i>Per lb.</i>	<i>Per lb.</i>	<i>Per lb.</i>	<i>Per cord.</i>		
1	Richards S. Walsh and George B. Hannahs.....	\$25 75	\$23 75	\$11 00	\$0 03 1/2	\$0 04	\$0 03 1/2	\$8 90	\$4, 897 33	\$20, 093 79
2	Uriah Culbert.....	30 00	28 00	10 00	05	05	05	9 00	4, 862 33	20, 586 99
3	Green's Dredging Company.....	32 00	29 00	15 00	05	06	05	10 00	4, 052 29	24, 156 87
4	Duncan Dewar and Charles G. Wing.	40 00	30 00	20 00	06	07	08	10 00	4, 686 86	28, 040 58

* Contract awarded.

Abstract of proposals received and opened December 21, 1882, for dredging at Calumet Harbor, Illinois.

No.	Names of bidders.	2,500 cubic yards, more or less.	Total.
		<i>Per cu. yd.</i>	
1	Calumet and Chicago Canal and Dock Company *.....	\$0 17 1/2	\$4, 375
2	Green's Dredging Company.....	24 1/2	6, 125
3	Harry Fox & Co.....	26	6, 500
4	Chicago Dredging and Dock Company.....	28	7, 000

* Contract awarded.

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Abstract of contracts for Calumet Harbor, Illinois, in force during the fiscal year ending June 30, 1883.

With—	For—	Dated—	Expires—	Remarks.
Walsh & Hannahs.....	Pier extension.	January 24, 1883	June 30, 1883	Extended to July 31, 1883.
Calumet and Chicago Canal and Dock Com- pany	Dredging	January 20, 1883	June 30, 1883	Extended to August 31, 1883.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 7, 1882.

SIR: I have the honor to submit herewith a report, with map, from the Board of Engineer Officers constituted to comply with the following requirements of the river and harbor act of August 2, 1882:

Improving harbor at Calumet, Illinois: Continuing improvement, thirty-five thousand dollars: *Provided*, That with a view to the improvement of the Calumet River, in the State of Illinois, from its mouth to the fork at Calumet Lake, the Secretary of War shall appoint a Board of Engineers who shall examine said river and report upon the practicability and the best method of perfecting and maintaining a channel for through navigation to said fork at Lake Calumet, adapted to the passage of the largest vessels navigating the Northern and Northwestern lakes, limiting and locating the lines of channel to be improved by the United States, and of docks that may be constructed by private individuals, corporations, or other parties, and clearly defining the same under the direction of the Chief of Engineers, United States Army; and the Secretary of War shall report to Congress the result of said examination, and the estimated cost of the proposed improvement; also what legislation, if any, is necessary, to prevent encroachments being made or maintained within the limits of the channel designated as above provided for.

The accompanying map clearly defines the limiting lines of channel to be improved and of docks that may be constructed.

The views and recommendations of the Board are commended to favorable consideration.

Very respectfully, your obedient servant,

H. G. WRIGHT,
*Chief of Engineers,
Brig. and Bvt. Maj. Gen.*

Hon. ROBERT T. LINCOLN,
Secretary of War.

REPORT OF THE BOARD OF ENGINEER OFFICERS CONSTITUTED TO
COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT
OF AUGUST 2, 1882.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., October 6, 1882.

GENERAL: The Board of Engineer Officers convened by Special Orders No. 84, current series, from Headquarters Corps of Engineers, to examine and report upon the proposed improvement of the Calumet River, Illinois, has the honor to present the following report:

The Board was required to examine the river and report upon the practicability and the best method of perfecting and maintaining a channel for through navigation to the fork of the river at Lake Calumet,

adapted to the passage of the largest vessels navigating the Northern and Northwestern lakes, and to limit and locate the lines of channel to be improved by the United States, and of docks that may be constructed by private individuals, corporations, and other parties, and clearly define the same; also, to present estimates of the proposed improvement, and to designate the legislation necessary to prevent encroachments being made and maintained within the limits of the channel designated.

The Board met at the United States Engineer office at Chicago, Ill., on the 3d instant, and continued in session several days in the execution of the duties assigned. The maps and other sources of information bearing upon the subject were consulted, and a personal examination of the river was made from Lake Michigan to Lake Calumet.

There are no engineering difficulties presented in the way of excavating and maintaining a navigable channel from Lake Michigan to the forks of the river near Lake Calumet, and with proper regulations it is believed that after the completion of the channel the cost of maintenance will be comparatively small.

The largest class of vessels navigating the Northern and Northwestern lakes draw about 15 feet, and it is desirable that the river depth should be somewhat more than that at all stages. As the water level in the river depends upon that in Lake Michigan, which is subject to considerable fluctuations, the depth of channel should at least be 16 feet below the mean level of its surface.

It is the opinion of the Board that the importance of this improvement, together with the necessity for avoiding legal complications, justifies the recommendation that the channel to be improved and controlled by the Government be in general 200 feet in width, and that the boundaries of this channel be established as a dock line to limit any construction by private parties or corporations.

It is considered desirable to limit the channel as far as practicable by straight lines, a full description of which it has not been deemed necessary to insert in the report. They are, however, fully outlined in the accompanying map,* together with the ownership of the bordering lands. As these lands belong to private and corporate parties, and as it will be necessary in some instances to encroach thereon in the furtherance of this project, it is recommended that no part of the improvement be undertaken until the right of way be conveyed to the Government, and that it be fully released from all liability for damages to adjacent property. The lands bordering the river are low, marshy, and covered with water at times, and without the improvement of the channel are of comparatively little value. In presenting this project the Board does not intend to limit the distance between the docks to the width of 200 feet; on the contrary, it is desirable to have it wider, and to have slips constructed; but any excess beyond the width fixed upon by the Government should be improved by adjacent owners, the expense to the United States being limited to the excavation and maintenance of the channel of 200 feet herein recommended.

The Board approves of the recommendation of Major Lydecker that the work be done by machinery owned by the Government, experience having shown conclusively that by this means the expense will be much less than by contract. In addition it may be stated that it will be necessary to retain one of the dredges, after the completion of the work, in order to keep and maintain the channel to its original depth and width, as undoubtedly more or less filling will occur from time to time.

* Omitted. Printed in Senate Ex. Doc. No. 9, Forty-seventh Congress, second session.

1750 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

It is the opinion of the Board that some legislation is necessary in order to prevent obstructions to the channel by vessels and other water craft, as well as to prevent encroachments upon the channel by parties using or owning the docks, and that a general law should be enacted, the main points of which are embodied in the draught herewith.

ESTIMATES.

The amount of material required to be excavated to make a channel in the Calumet River from Lake Michigan to the forks, 200 feet wide and 16 feet deep, is, in round numbers, 2,500,000 cubic yards. The lowest average price per cubic yard at which such work has been done by contract in this locality is 25 cents; this would amount to \$625,000.

The Board, however, recommend that the work be done by the Government owning its own dredges; the estimated cost being:

For dredges and outfit	\$100,000
2,500,000 cubic yards, at 5 cents	125,000
Total	225,000

This latter estimate is based upon the assumption that sufficient funds are appropriated at the outset to provide the necessary plant and perform a season's work.

D. C. HOUSTON,
Lieutenant-Colonel of Engineers, Brevet Colonel.
 JARED A. SMITH,
Major of Engineers.
 W. H. BENYAURD,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

AN ACT to preserve and prevent encroachment upon the excavated channel of the Calumet River, Illinois.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after the passage of this act, the Secretary of War is directed to assume full control over the channel of the Calumet River, to be improved by the Government, so far as the same may be necessary to prevent encroachment being made upon the improved channel-way, or any part of it that may be in course of excavation and improvement, and also to keep the same open and free from all obstructions, and he may establish such rules and regulations respecting the use of or passage through the said channel as he may deem necessary to protect the same and to facilitate the contemplated improvement.

Such regulations shall be conspicuously posted at the entrance of the harbor of Calumet, and copies of the same shall be printed in two daily papers of the city of Chicago.

These regulations may be changed from time to time, should it be deemed expedient for the better protection of the channel.

That it shall be the duty of all persons navigating said channel, or using it and its bordering docks, to observe the regulations prescribed by the Secretary of War, as aforesaid, and any person who shall willfully or negligently obstruct said channel, or make or attempt any encroachment upon the same, or cause any impairment, injury, filling up, or shoaling thereof, or who shall fail to obey and observe any of the prescribed regulations, shall be liable to a penalty of not less than fifty dollars nor more than five hundred dollars, to be recovered by information or by action of debt, with cost of suit, in the district court of the United States for the northern district of Illinois. And if such damage or injury to said channel or its approaches be caused by any steamer, vessel, or water craft, or by the masters of other persons in charge thereof, or if the master or other persons in charge of such vessel shall willfully or negligently violate the regulations aforesaid, a penalty of not less than fifty dollars nor

more than five hundred dollars shall be incurred, and such vessel shall be liable for the penalty aforesaid, and may be proceeded against by way of libel for the recovery thereof in any court of the United States within whose jurisdiction such vessel may be found.

That all bridges that may hereafter be constructed across the Calumet River shall be built and located under and subject to such regulations for the security of navigation and the maintenance of a free and unobstructed channel as the Secretary of War shall prescribe, and to secure that object the company, corporation, or other party desiring to build a bridge shall submit to the Secretary of War, for his examination and approval, drawings, with proposed location of such bridge, together with all information that may be necessary for a satisfactory understanding of the matter, and until the said plan and location be approved by the Secretary of War, said bridge shall not be erected.

Should any bridge constructed under this authority be found an obstruction to the free and convenient navigation of the said river, it shall be subject to modification or removal, at the expense of the owners thereof. And the authority for its construction may at any time be revoked by act of Congress, should the public good so require.

G G 3.

IMPROVEMENT OF ILLINOIS RIVER.

The project for the improvement of this river, now in course of execution, contemplates the construction of a lock and dam at each of the sites selected, Kampville and La Grange, and the dredging of the channel from the lock at Copperas Creek to the mouth of the river.

PROGRESS DURING THE YEAR.

The high water in the Illinois River caused a suspension of operations from September, 1881, to July, 1882. On the 19th of this latter month the plant (which had been undergoing repairs at Beardstown) was sent to the La Grange lock site, and the work of excavating the lock pit was commenced. In the mean time pile-driving and pumping machinery had been purchased, and when the water had fallen to a sufficiently low stage, about August 23, the coffer-dam (700 feet long and 200 feet wide) for this work was commenced, and completed October 4. The dam was then pumped out, and the pile-driving for the lock foundation was commenced on the 24th of the same month. The nature of the soil caused considerable difficulty in keeping the coffer-dam entirely free from water, and necessitated the use of three pumps working continually. The lock foundation was started early in November, and work continued upon it until January 6, 1883, when the closing of the river by ice put a stop to the work for the season. In addition to the construction of the coffer-dam and excavation of the lock pit, the following amount of work was accomplished upon the lock foundation proper at La Grange:

Number of bearing piles driven.....	1,800
Linear feet of longitudinal timbers laid.....	5,854
Linear feet of transversal timbers laid.....	12,890
Cubic yards of concrete laid.....	1,093
Linear feet of sheet piling driven.....	1,037

The work at the Kampville lock was not commenced until later in the season, owing to the high stage of water. On the 1st of September one dredge, with the necessary scows, &c., was sent to this lock site, and the work of excavating the lock pit and construction of coffer-dam was commenced. This latter work was of the same dimensions as that at La Grange, 700 feet long and 200 feet wide. The coffer-dam was completed September 22, and pumping was commenced the same day.

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On the 24th, when the water was reduced nearly 4 feet, one section of the dam showed signs of weakness. This part was immediately reinforced by building a section of dam wall 175 feet in length on the outside of the original work. This proved entirely sufficient, and no further difficulty was experienced. One pump was amply sufficient to keep the water in lock pit down, after the pit had been emptied. The lock foundation was commenced October 14, and work thereon continued until December 23, when high water, caused by an ice gorge in the river, put an end to operations for the season. In addition to the construction of the coffer-dam and excavation the following amount of work was accomplished:

Number of bearing piles driven	3, 357
Linear feet of longitudinal timber laid	7, 444
Linear feet of transversal timber laid	15, 134
Cubic yards of concrete laid	930
Linear feet of sheet piling driven	800

During the winter and spring season the entire plant was overhauled and thoroughly repaired for operations during the coming season. This work has been under the immediate supervision of Mr. R. A. Brown, assistant engineer.

The land at both lock sites was condemned by the United States circuit court at Springfield on June 22, and awards, amounting to \$582.50, were made to the various parties in interest. The proceedings had not at last accounts been forwarded to the Department of Justice for final approval though the United States attorney has informed me that everything relating to the condemnation was perfectly satisfactory.

Advertisements inviting proposals for stone for lock walls were published March 20, 1883, and opened April 21. The lowest bid was that of Sanger and Moody, of Joliet, Ill., to whom the award was made, contingent upon the approval of the land condemnation proceedings by the honorable the Attorney-General of the United States.

PROPOSED APPLICATION OF FUNDS AVAILABLE.

The amount available June 30, 1883, exclusive of outstanding liabilities, is \$290,514.18. This will be applied to finishing the lock foundations at La Grange and Kampsville; purchasing stone for the La Grange lock, in accordance with the proposal of Sanger and Moody, and laying the same to the extent of the funds available.

The long season of high water not only retarded operations, but added to the cost of construction of the lock foundations otherwise, on account of the necessity of repumping the lock pits whenever operations were to be resumed. The cost of pumping also was greatly increased at the La Grange lock, due to the springy nature of the soil. Three pumps had to be kept constantly at work, in order to keep the water in the lock pit down to a level sufficiently low to allow the men to get in the foundation timbers; whereas at Kampsville one pump was sufficient to keep the water at a proper level. At this latter site, I found it necessary to double the number of bearing piles, due to the nature of the subsoil. This was found to be different from what had been at first supposed, when the original boring was made. Its character was not definitely ascertained until we commenced the pile driving.

It is proposed to build the walls wholly of masonry, as at Herny and Copperas Creek, instead of concrete, with masses of stone imbedded; to raise them to the height of about 30 feet, so as to take them above the highest water ever known; and to extend the upper and lower wing walls. Taking into account the above changes, I have deemed it ad-

visable to revise the estimate for the entire work of lock construction. Estimating the cost of the masonry upon the basis of the lowest bid, that of Sanger and Moody, together with the cost of the foundations, I have increased the estimated cost of the lock foundations and locks complete to \$360,000 each, leaving the cost of the dams as originally estimated.

ESTIMATE FOR THE YEAR ENDING JUNE 30, 1885.

It is expected that the awards for the lands condemned will be approved at an early date, when the contract will be made with Messrs. Sanger and Moody, in accordance with their proposal of April 21.

The funds now available will, in addition to other necessary work on the foundations, complete the lock at La Grange, which will be accomplished in the course of the present season, so that at the end of the present fiscal year the funds will be totally exhausted. Should the necessary appropriation be made for the continuance of the work, the entire plant will then be transferred to Kampsville, and the construction of that lock commenced.

Estimated cost of the locks and dams.....	\$850,000 00
Appropriated and made available for entire work (in round numbers)...	573,000 00
Expended for dredging and dredging outfit	88,500 00
Amount available for lock construction.....	484,500 00
To complete the work will require, therefore.	365,000 00
Amount available June 30, 1883 (including outstanding liabilities).....	105,634 30
Annual cost of operating the dredging outfit.....	25,000 00

The locks should be completed as soon as possible in order to open the river to ordinary low-water navigation at all times, and would respectfully recommend that a sufficient allotment be made to carry on the work satisfactorily during the coming season.

The amount, exclusive of previous appropriations, necessary to complete the present plan of improvement, is \$365,000, exclusive of dredging.

There is submitted below a statement of the amount of commerce on the river. This affords, however, no adequate measure of the importance of the proposed improvement, for when the latter is completed, taken into consideration with the enlargement of the Illinois and Michigan Canal, there will be a continuous line of water communication through from the lakes to the Mississippi, adapted to the largest class of steamers.

Illinois River is in the customs district of New Orleans.

The length of the section below Copperas Creek lock remaining to be improved is 135 miles.

Money statement.

July 1, 1882, amount available	\$281,319 53
Amount appropriated by act passed August 2, 1882	175,000 00
	456,319 53
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$150,685 23
July 1, 1883, outstanding liabilities.....	15,120 12
	165,805 35
July 1, 1883, amount available.....	290,514 18
Amount (estimated) required for completion of existing project.....	547,150 55
Amount that can be profitably expended in fiscal year ending June 30, 1885.	350,000 00

1754 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of proposals received and opened April 21, 1883, for furnishing stone for improving Illinois River.

No.	Names of bidders.	Cut stone, dressed face, 2,070 cubic yards.	Cut stone, quarry face, 1,650 cubic yards.	Squared stone, 4,630 cubic yards.	Special stone, 1,650 cubic yards.	Backing stone, 4,870 cubic yards.	Total.
		<i>Per yd.</i>	<i>Per yd.</i>	<i>Per yd.</i>	<i>Per yd.</i>	<i>Per yd.</i>	
1	W. S. Hopkins & Co	\$17 00	\$14 00	\$10 00	\$29 00	\$9 00	\$202,480 00
2	John Tomlinson and David Reed	20 25	16 74	15 12	20 25	15 12	251,786 50
3	Black & Davis	19 50	17 90	11 60	27 40	9 20	221,307 00
4	Sanger & Moody*	16 70	15 25	10 35	26 35	9 00	200,960 00
5	Chicago and Lamont Stone Company	25 00	24 00	12 50	20 50	12 50	261,675 00

* Lowest bid.

COMMERCIAL STATISTICS.

Number of boats departed from Saint Louis, Mo., for the Illinois River, 214.

Number of boats arrived at Saint Louis, Mo., from the Illinois River, 228.

Statement of freight received and shipped via Illinois and Michigan Canal at Chicago, Ill., in 1882.

Articles.	Receipts.	Shipments.
Barrels, empty	pounds 81,130	
Boats	miles 156,902	152,837
Brick	number 1,279,500	11,000
Corn-meal	pounds 355,174	
Coal and coke	tons 2,603	4,602
Corn	bushels 2,539,825	
Carpenters' and joiners' work	pounds	21,200
Furniture	do	5,100
Flour	barrels 53,891	611
Iron	tons	35
Ice	do 40,646	
Lath	number	5,656,500
Lumber	feet 192,500	41,127,300
Lime	barrels	327
Machinery	pounds 9,040	13,750
Miscellaneous goods	do 545,827	1,456,400
Oil	barrels	124
Oats	bushels 368,844	
Posts and rails	number	40,478
Rye	bushels 20,321	
Railroad ties	number	1,711
Seeds	pounds 508,555	
Shingles	number 5,500	21,390,250
Stone	cubic yards 317,881	
Salt	barrels	3,857
Sand, gravel, and earth	tons 43,229	213
Wheat	bushels 118,124	500,393
Wood	cords 90	
Wagons	pounds 5,700	12,900

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SURVEYS FOR THE HENNEPIN CANAL, AND FOR THE ENLARGEMENT OF THE ILLINOIS AND MICHIGAN CANAL.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., March 31, 1883.

GENERAL: I have the honor to present the following report upon the surveys of the Hennepin Canal, as authorized by the act of Congress passed August 2, 1882, and assigned to my charge by letter from your

office under date of August 11 last. The full text of the section of the act referred to is as follows:

That the Secretary of War be, and is hereby, authorized and directed to survey and locate a canal from a point on the Illinois River at or near the town of Hennepin, by the most practicable route to the Mississippi River at or above the city of Rock Island, with a branch canal or feeder from the most practicable and convenient point on Rock River to the most practicable and convenient point on the main line of said canal. Said canal and said branch shall not be less than seventy feet wide at the water line, and not less than seven feet in depth of water, with locks not less than one hundred and fifty feet in length and twenty-one feet in width, and with a capacity for vessels of at least two hundred and eighty tons burden; and for that purpose the Secretary of War shall have power, by engineers and agents employed by him, to enter upon any lands for the purpose of making the necessary preliminary examinations and surveys; and the cost of construction, the annual cost of maintenance, and economy of use of said canal when completed shall be estimated and accompany the said surveys; and the Secretary of War shall cause to be made, by skillful engineers of the Army, a survey of the Illinois and Michigan Canal, connecting the Illinois River with Lake Michigan at Chicago, and estimate the cost of enlarging the same, so as to correspond in dimensions with the proposed canal between Hennepin and the Mississippi River, and to report to the next session of Congress the cost of enlarging said canal and the construction of the canal between Hennepin and the Mississippi, and the right of way therefor; and for the purpose of this paragraph the sum of thirty thousand dollars or so much thereof as may be necessary, is hereby appropriated: *Provided*, That nothing herein shall be construed to commit the Government to proceed with the construction of the said improvement.

Upon the approval by the Department of the project for the survey, the necessary arrangements were made for putting the parties into the field, with a view of commencing the survey at the earliest date practicable, and completing it before the winter season set in. Three parties were at once organized; one for the main lines between the Illinois and Mississippi rivers; a second for the feeder from Rock River, while to a third was assigned the survey of the Illinois and Michigan Canal, with a view to its enlargement. The surveys of the main lines and feeder were under the charge of Mr. H. B. Herr, assistant engineer; that of the Illinois and Michigan Canal was first under Mr. Thomas Merritt, afterwards under Mr. George Y. Wisner, who completed the work and rendered the report thereon

HENNEPIN CANAL.

FORMER SURVEYS AND ESTIMATES.

A survey for a canal between the Illinois and the Mississippi was made for certain parties in 1866, by Mr. J. O. Hudnutt, civil engineer. The route selected started from Hennepin and ended in the vicinity of Watertown, on the Mississippi, with a feeder from Rock River, at Dixon.

In connection with this survey other lines were run from the vicinity of Watertown to Moline and Rock Island, and thence back to the original line near Colona, via Rock River, but they were not adopted as any part of the main line, nor were they considered in the estimates. The canal proposed by Mr. Hudnutt was 60 feet on the water line, and 6 feet deep, with locks 150 by 21 feet; the feeder was 60 feet wide and 5 feet deep. The total estimated cost of construction was about \$4,500,000.

In 1870 the first survey for the Government was made under the direction of Col. J. N. Macomb, by Mr. Gorham P. Low. The route selected followed the Hudnutt survey very closely both on the main line and the feeder. The latter was carried as before from Rock River above the Dixon Dam. This survey was for a ship-canal 160 feet on the water line, and 7 feet depth, with locks 350 feet long and 75 feet wide, corresponding in size with those intended for the improvement of the Illinois

River. The feeder was 140 feet wide on water line and 7 feet deep. The estimated cost of the whole being \$12,479,693. Based upon the results of that survey there were also submitted at the same time estimates amounting to \$3,899,722 for a commercial canal of the same dimensions as proposed by Hudnutt, but with composite locks.

In 1874, in connection with the question of the transportation routes to the seaboard, another survey was ordered for a canal connecting the Illinois and Mississippi rivers, including also the Illinois and Michigan Canal. For want of time only this latter survey was completed, and for the former the line surveyed in 1870 was adopted, and estimates made and presented for a canal between Hennepin and Watertown, with locks 170 feet long and 30 feet wide; the cost of construction being estimated at \$4,541,000.

PRESENT SURVEYS.

The act of Congress as above quoted authorized the survey and location of the most practicable and convenient route between the two rivers, and its wording as interpreted by me was that while the original line known as the Hennepin Canal Route (from Hennepin to Watertown) had been surveyed and estimated upon several times, and its main features were well known, there were and might be other lines that would afford a more practicable, convenient, and economical canal communication between the two rivers. That other routes than the one to Watertown have been urged is evidenced by the fact that in the report of the Senate Committee on the Transportation Routes to the Seaboard, the following paragraphs touching on this point occur:

It is also proposed that the western terminus of the canal shall be at a point on the Mississippi about 20 miles above Rock Island. . . . It has also been proposed to substitute a line running from Chicago almost directly west, and striking the great eastern bend of the Mississippi at or near Fulton, Ill. The practicability of neither of these two lines has yet been determined by means of a survey.

It might here be incidentally mentioned that a line could possibly be found, starting from the vicinity of the feeder junction, and running in a northwestwardly direction, coming out near Fulton, as above proposed, and fulfill the conditions required by the law. For convenience of description and comparison I have divided the line into two divisions, viz, the eastern and western. The former includes that portion from the Illinois River to the summit level at the feeder junction, and the latter from that point to the Mississippi. For this western division three lines were surveyed, and are designated, respectively, as the Marais d'Osier* Route, the Watertown Route, and the Rock Island Route. It had been the intention at first to survey only the first, and by comparison with the data furnished by the former surveys make up the estimates for the other lines, with the same sized canal and locks, but for reasons set forth in the communications to the Department by those particularly interested in the Watertown and Rock Island routes, it was finally decided to re-run these two lines and make up the estimates therefor direct.

That portion of the line from the Illinois River to the feeder junction, a distance of 25 miles, is common to the three routes; at this point the Marais d'Osier line diverges, while the other two lines continue in common to the fifty-seventh mile from the Illinois River, near Colona, when the Rock Island line diverges, via Green and Rock River, to its termination, while the Watertown Route is continued westwardly to the Mississippi.

* Usually known as Meredosia.

EASTERN DIVISION.

Various surveys demonstrate that the only feasible line westward from the Illinois River in the vicinity of Hennepin was through the valley of Bureau Creek. The initial point of the present survey is $1\frac{1}{2}$ miles north of the town of Hennepin, at Spring Lake, where a favorable site exists for construction of a basin, thence the line is continued up Bureau Creek Valley to the fifteenth mile, crossing the Rock Island Railroad at a point 3 miles from the Illinois River, and is maintained north of the railroad the remainder of the distance, passing under the Chicago, Burlington and Quincy Railroad, at the seventeenth mile. At the fifteenth mile the route enters Pond Creek Valley, and reaches the summit level at the eighteenth mile.

The summit level is 7 miles long, and at its western extremity, a point about 4 miles north of Sheffield, receives the feeder from Dixon.

WESTERN DIVISION.

Marais d'Osier Route.—From the feeder junction this line runs north-westwardly, following the valley of Hickory Creek to about the thirtieth mile from the Illinois River. It then enters Saint Peter's Marsh, crosses Green River by an aqueduct 430 feet long, is then carried through One Hundred Acre Slough and Big Slough, and around Spring Hill to a bayou leading into Rock River, reaching this river $1\frac{1}{2}$ miles south of Erie, at the fiftieth mile. The stretch through the marsh and sloughs, as above, is level, and in length about 16 miles, requiring but little heavy cutting or embankment. It is proposed to cross Rock River in a pool formed by a dam to be built 700 feet below, and of sufficient height to give the required depth of water. On the west side of Rock River another bayou is taken advantage of, carrying the canal about a mile, thence a direct course is taken across the depression known as the Marais d'Osier, and at the western extremity thereof, takes a slough by that name, to the Mississippi nearly opposite the town of Comanche, and about 2 miles below Albany. The slough at the entrance to the Mississippi affords facilities for the excavation of a protected basin. The total length of this entire line is 64 miles.

Watertown Route.—Starting from the feeder junction, as before noted, the line follows generally the route formerly surveyed, crossing to the south side of Hickory Creek Valley, thence in a westerly direction, passing near the towns of Annawan and Atkinson, and reaching the vicinity of Green River near the forty-sixth mile. Continuing near this river, the line passes 2 miles north of Geneseo at the forty-ninth mile, and thence to Green River at the fifty-eighth mile. It is proposed to cross this latter by an aqueduct 400 feet long, thence the route is carried to Rock River, where a crossing is effected by an aqueduct 1,500 feet in length. From Rock River to the Mississippi a low, flat depression is followed, and Watertown reached at the sixty-fourth mile. Here the Mississippi affords but 2 feet at extreme low water over a rocky bottom, and therefore the excavation must be carried a distance of about 1 mile in order to reach the channel of 4 feet, excavated by the Government through Campbell's Chain. The total length of this route is 65.2 miles.

Main line to Rock Island.—This route branches off at the fifty-eighth mile on the Watertown Route, and enters Green River at the fifty-ninth mile. It follows that river to its junction with Rock River, thence down the latter to Milan, and across the low point to the Mississippi about $1\frac{1}{2}$ miles below the city. The total length of this line is 74.5 miles.

The route via Green and Rock River is made feasible by the construction of two dams, and by raising the existing dam at Milan.

The aggregate lockage from the Illinois River to the summit level is 205 feet, requiring twenty-three locks with lifts from 7 to 10 feet; thence to the Mississippi the descending lockage via the Marais d'Osier is 75 feet, requiring eight locks; via Watertown, 86 feet, requiring nine locks, and via Rock Island 101 feet with twelve locks.

FEEDER BRANCH.

The law provided for a feeder from Rock River. The nearest point on that river having sufficient elevation for the purpose is above the dam at Dixon, and accordingly the line was started there. To avoid expense and complications with the corporations controlling the right of way down the avenue at Dixon, through which it was necessary to carry the feeder, it is proposed to form a basin below the Illinois Central Railroad embankment, and to supply this basin by a channel of narrower dimensions than those proposed for the feeder, leading to the pool above the dam, and so arranged as not to interfere with the operations of the mills.

From the basin the line follows the river to about the tenth mile; it then turns southward through the flat prairie land and the Winnebago swamps, and reaches Green River at New Bedford in the thirtieth mile from Dixon. Green River is crossed by an aqueduct 150 feet long, and the line is carried thence to the junction of the main line at the western extremity of the summit level. The total length of the feeder is 37.1 miles, with a fall of 3 feet.

DIMENSIONS OF CANAL AND LOCKS.

It is proposed to make the canal and feeder 80 feet wide on the water surface, and 7 feet deep, with slopes of 1 on 1½. The locks for the main canal are 170 feet long and 30 feet wide. These latter dimensions were adopted after considering the question of low-water navigation on the Upper Mississippi, as affecting barge transportation. The hull measurement of the larger size barges adapted to the passage of the locks is, according to the custom-house authorities, about 300 tons, though with deeper water afforded by higher stages of the river, and also by the proposed dimensions of the canal, such barges can, with the box-top, carry over 600 tons; but we had to be governed by the minimum draught of the boats at the most unfavorable stage of the main river.

The same lock dimensions for the Hennepin Canal were also adopted by Colonel Macomb in the report of 1874, in connection with the subject of transportation routes to the seaboard.

The locks and the accessory works for the canal, such as culverts, weirs, &c., are of the usual type designed for works of like character, and need no special description. The number and location, together with all other details, are fully set forth in the accompanying report.

It will be noticed that no provision has been made for the protection of the slopes, arising from the fact that it was impossible to determine, until the work of excavation was carried on, precisely when such protection would be especially needed.

WATER SUPPLY.

In this, as in former surveys, it is provided that the water should be supplied the canal from Rock River, and that the feeder should be of

the same dimensions as the main canal. To supply the losses due to lockage, evaporation, absorption, filtration, leakage, and other incidental causes, the amount necessary for the different routes to be supplied from Dixon has been calculated as follows:

	Cubic feet per day.
Marais d'Osier line.....	13,634,000
Watertown line.....	14,690,000
Rock Island line.....	14,338,000

The computations therefor agree in the result with those derived from the figures for water consumption as presented by Colonel Merrill in his translation of Graeff's *Canal Construction and Water Supply*. It will be observed that the western section of the Marais d'Osier line between Rock River and the Mississippi, a distance of 16 miles, is fed from Rock River at the point of crossing the former river, and not from Dixon; and that the Rock Island Route also draws a portion of its supply from lower Rock River, which it traverses. To determine the quantity chargeable to lockage it has been assumed that the maximum number of boats that can pass the summit level in one day is 90, at the same time considering that the movement is not entirely in one direction, but that a proper proportion of boats go each way, and under that supposition one and a half lockfuls to each boat is an ample allowance.

It has been feared by those interested in the development of the water-power at Rock River that the abstraction of the amount of water necessary for canal purposes would result in injury to the manufacturing interests at various points along the river. Taking the canal at its maximum capacity of ninety boats per day, there would be taken from the river, at its very lowest stage, for the Marais d'Osier Route, 5.2 per cent. of the discharge of the river at that time; for the Watertown Route, 5.7 per cent.; and for the Rock Island Route, 5.5 per cent. The river, however, has not been at its very lowest stage since 1870, and it must be observed that should the canal be constructed it will undoubtedly be many years before it would be taxed to its maximum capacity. In the mean time arrangements could be made to supply the canal from other sources along the line, utilizing portions of the swamp areas for storage reservoirs for the summit level. Under such conditions, I do not consider that any fear need be entertained of danger to the water-power interests on Rock River. To lessen as much as possible the amount of leakage at certain points on the main line and feeder where the canal is excavated through sandy and gravelly soil, notably in Bureau Creek Valley and on the Watertown line, it is proposed to insert a lining of concrete about 6 inches thick.

RIGHT OF WAY.

A width of 90 feet on each side of the center line of the canal has been reserved and estimated for in the right of way, and a valuation put upon the same derived from information respecting the value of land in the vicinity. At the same time care has been observed in locating the lines to avoid as far as possible encroaching upon valuable land or buildings. It is proposed to inclose the entire right of way by a wire fence.

MAINTENANCE.

Under this head are included the amounts necessary for the care, preservation, and repairs of the canal; the pay of all employes as assistant engineers, lock and bridge tenders, office expenses, &c., all of

which will have to be provided for annually. In addition there will undoubtedly have to be made from time to time appropriations for extraordinary repairs, renewals, &c., which cannot be estimated beforehand.

COMMERCIAL STATISTICS.

For the information concerning the commercial importance and the general effect and benefit of the construction of the canal on the transportation of the products of the Northwest, I am greatly indebted to Mr. Edward Russell.

GENERAL CONDITIONS AFFECTING THE DIFFERENT ROUTES.

The surveys demonstrate that a perfectly feasible route exists for a canal from the Illinois River, near Hennepin, to the Mississippi, at or above Rock Island. The question as to the selection of the best one can only be settled after a consideration of the advantages and disadvantages of each.

In this comparison we are mainly concerned with the lines west of the summit level, as the line of the eastern division is common to all routes. This latter division is very expensive considering its length of only 18 miles, being at an average cost of \$98,074.77 per mile; while on the western division the Marais d'Osier is \$43,360.12 per mile, the Watertown \$76,906.77, and the Rock Island \$51,654.62; the feeder averages \$44,852.92 per mile.

In an engineering point of view the Marais d'Osier presents decided advantages arising from the nature of the country through which the line is carried, and the character of the soil. These render the work of excavation and construction easier, with a corresponding reduction in the estimated cost over the other routes. No rock is met with, as is the case at points on the Watertown and Rock Island routes. An objection has been urged to this route that it is impracticable to carry a canal through the Marais d'Osier. It may be observed, on the contrary, that probably no other portion of this or the other lines presents such favorable features for canal construction. On this point I quote from the report of General J. H. Wilson on the improvement of Rock River by slackwater navigation:

In connection with the Rock River survey, I caused the Marais d'Osier, a swampy stretch of country extending from the Rock River to the Mississippi, to be surveyed by my assistants, Messrs. Abbott and Morgan, civil engineers. It is reported that during high water in either river this marsh is flooded so that boats may pass from one to the other.

The map and profile of this survey will be prepared without delay, and forwarded to the engineer department. They show the practicability of making a branch canal along the line whenever the interests of the country may demand it.

On the question of water supply, the Marais d'Osier Route is fed from the Dixon Dam only as far as the crossing of Rock River, while the Watertown Route must be supplied its entire length, 16 miles greater, and the Rock Island Canal 10 miles greater, an advantage to the Marais d'Osier Route.

The Watertown Route ends at the Mississippi on the rapids, through which the Government has excavated a channel of 4 feet depth. In order to reach this channel, which is on the Iowa side of the river, it will be necessary to excavate a channel over a mile long, through rock, in order to obtain 4 feet depth as an entrance into the canal. Sufficient depth of water is found at the terminus of the other routes. The number of accessory works, as culverts, bridges, &c., on the Watertown

and Rock Island routes, is double of what is found necessary on the Marais d'Osier, adding not only to first cost of construction, but increasing the annual cost of maintenance and the liability for extraordinary repairs and renewals hereafter. The route also affords a protected basin at its western extremity, which cannot be found on the other lines, except at great expense.

In a commercial point of view the selection of either one of the lines depends upon the section of the country it is intended to benefit. The distance from the upper line to Saint Paul is 350 miles, and if the canal be considered as an extension westward of the navigation of that part of the Upper Mississippi, the distance to Chicago is, by the Marais d'Osier route, 21 miles shorter than by Watertown, and 40 miles shorter than via Rock Island, and at the same time the navigation over the Rock Island rapids is avoided.

Of the feeder it may be said that the law required that it should run from Rock River, probably because that stream can at all stages be depended upon to furnish a reliable supply of water. It is 37 miles long, and in that respect adds greatly to the cost of construction and expense of maintenance, and is objectionable on the ground that upon it alone, with the exceptions before noted, depends the entire water supply. Should a break or any such accident happen to it, the entire canal would be deprived of the water necessary for its successful operation. It might here be noted also that its size was required to be that of the main canal. If it be designed simply as a feeder, there is no necessity of having it of the dimensions designed. Should the construction of the canal be hereafter authorized, I think it would be desirable to investigate the question of supplying the canal from other sources, as no doubt the areas of swamp lands between Rock and Green rivers can be utilized for that purpose.

The Marais d'Osier presents these advantages over the others: It is the shortest and most practicable line between the two rivers. The nature of the country through which it passes renders the construction of all work upon it easier, and hence its cost of construction is less.

The annual cost of maintenance is less, and it is more than likely the expense of extraordinary repairs and renewals will be less. The supply of water is the least, and better regulated.

ENLARGEMENT OF THE ILLINOIS AND MICHIGAN CANAL.

This survey, which was commenced in September, 1882, and finished early in the following November, embraced only a remeasurement of the lines and sections of the canal and accessory works throughout the entire length from Chicago to La Salle, for the purpose of obtaining information necessary to estimate the cost of enlarging the same to correspond with the proposed dimensions of the Hennepin Canal. The locks now in use are 110 feet long by 18 feet wide.

Other surveys and estimates have heretofore been made and presented, but they were for a ship canal, with locks 350 by 75, the size now in course of construction on the Illinois River. The information obtained during the present survey can be utilized for calculating the cost of enlarging the present canal to any other size than that now proposed, should it be deemed necessary.

The lockage, which is all descending, amounts to 141.5 feet, requiring for that purpose sixteen locks, with lifts varying from 6.5 to 13.5 feet. The water will be supplied by pumps, now in course of construction at Bridgeport, which furnish 1,000 cubic feet per second.

1762 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

It is not proposed to make any change in the present line of the canal nor in the number and location of the locks and other structures.

In the new constructions a considerable portion of material from the old locks and from the canal lands could be utilized in various ways.

The estimated cost of the enlargement of the canal, locks, and other structures is \$2,298,919.15.

In estimating for maintenance, I have been governed somewhat by the expenses of the present canal.

For the ordinary repairs, maintenance, and extraordinary repairs, &c., there has been expended for the past ten years an average of \$93,235 per annum, of which amount an average of \$47,817 per annum has been charged to maintenance and ordinary repairs, and I have taken the cost of the same on our proposed work at \$50,000.

By an act of the legislature of the State of Illinois approved April 28, 1882, the canal was ceded to the United States, provided the same be accepted within five years, which cession was ratified by a majority of all the votes polled at the election held in November last.

A copy of the act is appended.

ESTIMATES.

MARAIIS D'OSIER ROUTE.

Estimated cost of construction of canal and feeder, including right of way	\$5,811,367 50
Estimated cost of maintenance and ordinary repairs annually	83,600 00
Outfit of dredges, boats, &c	36,000 00

WATERTOWN ROUTE.

Estimated cost of construction of canal and feeder, including right of way	7,207,646 88
Estimated cost of maintenance and ordinary repairs annually	91,245 00
Outfit of dredges, boats, &c	36,000 00

ROCK ISLAND ROUTE.

Estimated cost of construction of canal and feeder, including right of way	6,672,890 67
Estimated cost of maintenance and ordinary repairs annually	94,820 00
Outfit of dredges, boats, &c	36,000 00
The length of the feeder from Rock River at Dixon is 37 miles, and its estimated cost, included in the above, is	1,664,117 52

ENLARGEMENT OF THE ILLINOIS AND MICHIGAN CANAL.

Estimated cost of construction	2,298,919 15
Estimated cost of maintenance and ordinary repairs annually	50,000 00

There are transmitted herewith the reports of Mr. H. B. Herr, assistant engineer, on the surveys of the Hennepin Canal, and Mr. George Y. Wisner, assistant engineer, on the Illinois and Michigan Canal, together with 15 sheets of maps and profiles pertaining to the same.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

SURVEYS FOR A CANAL FROM THE ILLINOIS RIVER NEAR HENNEPIN TO THE MISSISSIPPI RIVER AT OR ABOVE ROCK ISLAND, ETC.

REPORT OF MR. H. B. HERR, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., March 15, 1883.

MAJOR: I have the honor to submit the following report upon surveys for a canal route from the Illinois River near Hennepin to the Mississippi River at or above Rock Island, with a feeder branch from Rock River.

The dimensions adopted in a conference with you for the canal and feeder branch to accommodate boats of about 300 tons burden are the following, viz:

	Feet.
Widths at water surface.....	80
Depth of water.....	7
Top width of banks.....	8
Inside and outside slope of banks, 1 on 1½.	
Length of locks between miter sills.....	170
Width of locks between walls.....	30

Upon the receipt of your instructions, on August 28, 1882, to make the survey, a party, under the immediate charge of General Charles A. Gilchrist, was organized and went into camp at Dixon, Ill., on September 5, and commenced the survey of the feeder branch at that place, with instructions to follow as nearly as practicable the line surveyed by Mr. Gorham P. Low in 1870, under direction of Col. J. N. Macomb, Corps of Engineers, except where a better location could be found.

A description of this line will be given further on in this report.

MAIN LINE, VIA THE MARAIS D'OSIER.

After the Dixon party was well under way, and a second party organized, with Mr. Charles E. Taft in immediate charge, I made a careful reconnaissance of the low lands contiguous to the west bank of the Illinois River, in the vicinity of Hennepin, and also of the Bureau Creek Valley, for a distance of several miles westward. In the mean time the survey party had assembled and went into camp September 12. The organization included the following sub-parties, viz: Transit, topographical, main-levels, and cross-section party.

Evidently the only feasible route from near Hennepin to about 15 miles westward lies within the valley of Bureau Creek, a stream usually of small proportions, but which becomes in the flood season a torrential river, as evinced by the water-marks left on trees, buildings, and other structures by the flood of July, 1882. These marks have an average height above low water of about 14 feet. An oscillation so great necessitates avoiding the lowest line of the valley in canal construction. Another prominent and considerable obstacle to an economical construction through many parts of this valley is the Chicago, Rock Island and Pacific Railway, which has naturally taken the most practicable location between the stream and bordering hills.

As the stretch across the bottom lands from the Illinois to entrance of Bureau Creek Valley must be made at a great cost for earthwork (on account of 20 feet oscillation of the river), the point selected for the terminus of the line was adopted with the view of shortening this distance, and at the same time to secure a good entrance to the river where the channel lies along the west bank. This point is about 1½ miles above Hennepin, and satisfies the above requirements. Here, at about 400 feet from the river bank, a natural depression called Spring Lake is crossed by the line, and a basin for laying up boats is proposed.

Instead of constructing the canal in embankment across the low land, it will be in excavation to the higher land near the first mile, where a flight of two locks with lifts of 9 feet each will be placed and arranged as a guard-lock. About one-half mile from these locks the Peoria branch of the Chicago, Rock Island and Pacific Railroad is crossed with water surface in canal 14 feet below rails. A fixed bridge and a raise of 3 feet in grade of the railroad will give 15 feet head-room for boats. In view of the damage a railway sustains from the introduction of a pivot-bridge in its line, as few crossings at grade as possible have been made. The first is near the three-mile station at Lepertown Mill, and requires a pivot bridge. This is the only crossing of the Chicago, Rock Island and Pacific Railroad, though the line lies contiguous to its right of way most of the distance from this crossing to Pond Creek Station near Wyandot. At many points in this stretch the cost of construction would be lessened by more than half if the railway right of way were encroached upon, and especially if the track were moved at several points.

East Bureau, a branch of Bureau Creek, is crossed on an aqueduct 270 feet long, about the fourth mile; the main stream is crossed twice on aqueducts, each 270 feet long, at the seventh and twelfth miles, respectively.

After crossing West Bureau Creek, also by a 700-foot aqueduct, the line leaves Bureau Creek Valley at the fifteenth mile and enters Pond Creek Valley. The only town near the route thus far is Tiskilwa, where the line passes about 1,000 feet north of the railway. Near this town two mill-races are cut, but provision is made for their maintenance. In many places near Bureau Creek gravel and sand predominate to such an extent that a special lining of concrete is required.

Throughout the first mile, after entering the valley of Pond Creek, the railway offers a great obstacle, forcing the line into the bluffs, and to give access to the station of Pond Creek the highway leading from Wyandot must be carried over the canal, railway, and Pond Creek, a total distance of 350 feet.

A short distance beyond the station the line swings to the northward, and, following up a small ravine, passes under the Chicago, Burlington and Quincy Railway about a mile south of Wyandot, at an elevation such that surface of water in the canal would be 21 feet below the rails. The arch under railway will be in the prolongation of lock-walls, and only 30 feet wide. Provision is made for taking the small rivulet in this valley into the canal and wasting it out at the lower end of valley. On reaching the head of this valley a further change of course northward is made, crossing the Wyandot and Sheffield highway at the seventeenth mile, and reaching the summit-level a mile further on, where the bottom of the canal will be 198 feet higher than surface of water in Illinois River at Hennepin, requiring 22 lift-locks between.

Another line was surveyed over the summit, passing south of the one adopted, but was found to be more expensive, hence abandoned. It is shown on tracings.

With but little excess of embankment in crossing the Devil's Slough, and no seriously heavy cutting, this level continues 7 miles to the feeder junction at the twenty-fifth mile, and about 4 miles due north from Sheffield, skirting the Devil's Grove, and crossing Hickory Creek near the junction.

Before the survey had reached this point, and after our joint examination, early in October, of Marais d'Osier region between Rock and Mississippi rivers, I had your instructions to reach the Mississippi somewhere in the vicinity of this depression if easy access could be had from the feeder junction. Through much inquiry of persons familiar with the country to be traversed, and by a hurried reconnaissance of part of the region, I felt satisfied that a good route could be found in that direction, and conducted the survey with this view, after reaching the junction with feeder.

The route follows along the north side of Hickory Creek Valley to about the thirtieth mile and about four miles north of the town of Mineral; then crosses a low pass in a sand ridge, a distance of 2,500 feet, when Saint Peter's Marsh is entered. The first intention was to turn this sand ridge by passing further westward on lower and more level ground; but finding the cut through sand ridge would be more than compensated for by the gain in alignment, the latter line was adopted. Had this short cut been contemplated when the line was being carried down Hickory Creek Valley, more elevated ground near the bordering sand ridge would have been traversed, the drop of 6 feet by Lock No. 25 would have been omitted, the former level carried through to Saint Peter's Marsh, and the cut through sand ridge reduced by that depth. Time did not permit rerunning so much of the line, but if construction on this route is undertaken the change suggested is recommended. A lining of concrete is provided through the sand ridge.

The level commencing at the marsh extends through it to Green River, crossing at a point 7 miles north of Annawan on an aqueduct 430 feet long; thence in a general northwesterly course towards Spring Hill, in Whitesides County, crossing the One-hundred-acre Slough and Big Slough; its total length being 16 miles, with but little heavy cutting or embankment.

The water-way under the Green River Aqueduct will, in flood-time, operate as an inverted siphon; hence, to provide against the possibility of a rise above canal embankment, an inflow weir 600 feet long, with a corresponding waste on the lower side, is contemplated. Before this direct route from Green River to Big Slough was surveyed, a line had been run, following down Green River Valley and around the high bordering bluffs entering the One-hundred-acre Slough a mile south of where the adopted line enters. The entire stretch was remarkably level and favorable for construction, but the distance being about a mile greater than by the other line, economy in construction favors the one adopted.

The Big Slough is crossed at its summit, the waters draining southward into Green River and northward into Rock River.

Earthwork throughout almost the entire length of this level (16 miles) can be economically done by dredging, as water is plentiful.

Where ditches have been excavated in these swamps and sloughs, they usually show a few inches of black muck at the surface, resting on a substratum of clayey loam, together about 10 inches thick. Beneath this is either a thick bed of clay or

alternating strata of clay and sand, varying in thickness from 1 to 20 or more inches. Not only does this form an impervious bed suitable for canal construction through such localities, but the clay can be utilized for puddling in other adjacent parts of the line.

At Spring Hill the line makes a sharp bend to the west, rounding the hills and entering a bayou at the forty-ninth mile, follows it to Rock River, about a quarter of a mile above Fargo's Ferry and one and a half miles south of Erie. This stream would be crossed in a pool formed by a dam to be built about 700 feet below the line, and of sufficient height to maintain the pool at 6 feet above the stage as found at time of survey. Probably 800 acres of low land would be submerged by the pool, and that amount is included in the estimate for damages.

Another bayou entering the river from the west is followed nearly a mile, when the line strikes a direct course across the low, flat country between Rock and Mississippi rivers to near the fifty-eighth mile, on the same level as Rock River is crossed.

Near the bayou the Rock Island branch of the Chicago, Burlington and Quincy Railroad is crossed, requiring a slight raise of its grade and the insertion of a pivot-bridge.

At the fifty-eighth mile a 16-foot lift and guard-lock drops the bottom of canal to a depth of 7 feet below low water in the Mississippi where the Marais d'Osier Slough enters. From this lock an open channel would be dredged through the Marais d'Osier and the slough which drains it to the Mississippi opposite the town of Comanche and 2 miles below Albany. The total distance on the line from 7 feet depth of water in the Illinois to the same depth at low water in the Mississippi is 64 miles. The flood waters would pass freely over this last stretch of the canal without any further detriment than a small deposition of silt. There would be no current to waste the banks or interfere with handling of boats.

Just inside of the railway bridge which carries the Racine branch of the Chicago, Milwaukee and Saint Paul Railway over the Marais d'Osier Slough at its junction with the Mississippi a basin in this slough of about 9 acres area is proposed to be excavated, where complete protection from floating drift and ice is offered. To insure boat-way from canal to river at higher stages of the river pivot-bridges are necessary in both the railway and highway crossings at this point.

Soundings made from the terminus of the line around the head of Island No. 294, also southward between the island and mainland, show a minimum depth of 10 feet around the head to the main channel with a 3-foot stage, or 7 feet at low water; but only 9 feet at the same stage near the foot of the island. Hence the full depth of 7 feet could not be had in that direction during low water without some dredging. The soundings are marked in red ink on the accompanying map.

No excavation in rock occurs throughout this entire line.

The field-work on this line was completed November 20, when the party was disbanded, and Mr. Taft, with his principal assistants, Mr. John de La Camp, topographer, and Mr. William Lee, leveler, commenced the preparation of maps, profiles, and estimates.

THE FEEDER BRANCH.

This branch canal, intended also to furnish the necessary water supply for operating the main canal, must enter the latter somewhere on the summit level, and the requirement of the survey for the branch was to find and locate the most feasible route from Rock River to some point on the summit level.

From the survey made by Mr. Low in 1870 it was evident that the most easily accessible point on Rock River, of sufficient elevation to supply water to the summit level, was the pool formed by the dam at Dixon, Ill., and the survey was commenced at that place.

In its full canal dimensions (same as those of main line) the feeder branch begins with a proposed basin immediately west of the Illinois Central Railway, and between a branch track and Rock River, in the town of Dixon. A channel 30 feet wide and 5 feet deep leads from the basin under the Illinois Central Railroad to the race now supplying water-power to the Dixon Mills. That no damage may result to the water-power, and that at the same time entire control of the water supply to the feeder basin may be had, it is proposed to increase the raceway to 50 feet width and 5 feet depth from its lower end to the pool above the dam in Rock River (a distance of about 400 feet), placing a regulating bulkhead and drift-rack at junction with the river. In the wall on the river side sluice-gates will regulate the amount of water supplied to each consumer. The railway track now traversing the length of this raceway will be maintained in its place, and the entire distance of 400 feet planked over. At the junction of this 50 feet width with that of 30 feet recesses will be provided in the walls on each side for the reception of stop-bars, in order that water-power may be maintained while the canal may be empty, or *vice versa*.

Quite an expensive wall construction along the river bank results from exclusion from a far better location in the river street by the present railway location there.

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From the basin the line follows the river to about the eleventh mile, where a sweep to the south carries it over the flat prairie and the Winnebago Swamp to the Green River at New Bedford, 30 miles from Dixon. To avoid much rock-cutting and secure an easy curve around a high rocky bluff at the fifth mile, a heavy ripped embankment in the river is proposed. This, as well as the canal bank through the first 10 miles, will be carried 2 feet above extreme high water. Almost the entire distance along the river riprap will be necessary to protect the canal bank from high water, and in the eleventh mile sand and gravel are so predominant as to require a concrete lining.

The crossing of the Chicago and Northwestern Railway at the ninth mile requires a slight raising of its grade and a pivot bridge. Similar bridges are necessary at the Rock Falls branch of the Chicago, Burlington and Quincy Railroad, near the twelfth mile, and the Clinton branch of the same road at the twenty-third mile. The latter crossing is about $1\frac{1}{2}$ miles west of Deer Grove Station. The generally flat condition of the country in the Winnebago Swamp region required the running of several trial lines for some distance to determine the best route; and the line formerly located in 1870 was not adhered to strictly after leaving Rock River. Perhaps the route adopted is the best, though by making a greater detour westward less depth of excavation could be had, at the cost of bad alignment, however.

At New Bedford the bed of Green River lies at a depth of about 20 feet below the general surface of the country, and 15 feet below grade of the canal, between not distant banks, affording a good site for crossing on an aqueduct. The length of this structure will be 150 feet.

From New Bedford the line continues in a southerly course to the western terminus of the summit level on the main line at the twenty-fifth mile from the Illinois River, and 4 miles north of Sheffield; the total distance from Dixon being 37.1 miles. A basin, with guard-gate and waste-weir, is provided at the junction.

This part of the survey was completed October 21, and preparation of maps, profiles, and estimates was commenced by General Gilchrist and his chief assistants, Mr. H. W. Lewis, topographer, and Mr. Joseph G. Gilchrist, leveler.

The slope or fall the feeder branch should have to carry the amount of water necessary for operating the canal is arrived at in the following manner:

To determine the maximum quantity expended per day in the lockage of boats, I assume the maximum lockage capacity of a single lock to be 90 boats in twenty-four hours. If this number of boats all passed in one direction through the summit level, their lockage would draw therefrom 180 lockfuls of water. This is not a probable condition of navigation, however, and instead of the movement being all in one direction, it is safe to assume that the ratio of the number of boats passing in one direction to that moving oppositely would not be greater than 2 to 1. On this assumption 150 lockfuls would be the maximum quantity of water drawn from the summit level in twenty-four hours for lockage purposes. Hence, taking a lockage of a 10-foot lift-lock, equivalent to $170 \times 30 \times 10 = 51,000$ cubic feet, the maximum quantity drawn from the summit level daily would be $51,000 \times 150 = 7,650,000$ cubic feet.

The daily loss by evaporation, leakage, and percolation may be assumed as a quantity equal to 2 inches in depth over the entire surface of the canal supplied and the feeder. Rankine recommends this as a safe assumption, and M. Graeff, in his treatise on the "Canal du Marne au Rhin," names the same proportional quantity as the result of observations on that and other French canals. If, perchance, this loss should be exceeded in the infancy of the canal, percolations would have decreased so much, on account of sides and bottom being silted over, by the time navigation reached the proportions assumed herein, that less would be expended for lockage during the time of maximum percolation.

Two inches in depth over 1 mile 80 feet wide gives—

$$\frac{5,280 \times 80}{6} = 70,400 \text{ cubic feet.}$$

Hence, 48 miles of main line (from the first lock to Rock River) and 37 miles of feeder of same width will require $(48 + 37) \times 70,400 = 5,984,000$ cubic feet per day; and the total maximum quantity to be supplied daily is—

	Cubic feet.
For lockage	7,650,000
For evaporation, &c	5,984,000
	<hr/> 13,634,000

or 158 cubic feet per second.

The least sectional area of the feeder branch will be through the aqueduct at Green River, $36 \times 7 = 252$ square feet, requiring a mean velocity of $\frac{158}{252} = 0.627$ foot per second to pass the above maximum supply.

Probably none of the many formulæ expressing a relation between mean velocity, hydraulic mean depth, and slope in open water channels were derived from actual observations in a channel of the dimensions under consideration, yet we must resort to them for an approximate determination of the slope required in the feeder branch.

Taking Prony's formula:

$$V = (10567.02 R S + .0556)^{\frac{1}{2}} - 0.236,$$

in which

V = mean velocity in feet per second,

R = hydraulic mean depth = $\frac{\text{area of section in square feet}}{\text{wetted perimeter in feet}},$

S = slope = $\frac{\text{vertical fall}}{\text{horizontal distance}},$

and substituting for V and R the values 0.627 and $\frac{252}{50} = 5.04$, respectively, we find the slope $S = 0.0000129$, or 0.82 inch per mile, corresponding to a fall of $0.82 \times 37 = 30.3$ inches in the total length of feeder.

Substituting similarly in D'Aubisson's formula—

$$V = (8976.5 R S + .012)^{\frac{1}{2}} - 0.109,$$

we find $S = 0.0000117$, or 0.74 inch per mile, or $0.74 \times 37 = 27.4$ inches fall in total length of feeder.

Eytelwein's formula gives the same result as that of D'Aubisson.

Theoretically, then, a fall of about 29 inches from Dixon to the main line would be sufficient to carry the necessary water supply; but, to be on the safe side, I have adopted a fall of 36 inches in establishing the grade of the feeder. This can be secured without raising the dam at Dixon.

As this dam was built to supply water-power for milling and other purposes at Dixon, the amount of water that would be drawn from the pool for canal purposes becomes a matter of interest to those owning the water-power. Evidently the maximum daily draft on the pool will be less than the maximum of 158 cubic feet required for operating the canal, for the feeder, together with the summit level on the main line, may be regarded as an immense storage reservoir which may be drawn upon in times of maximum navigation, and instead of a daily supply from the river for ninety boats, no doubt a maximum of sixty per day will be ample. The amount for lockage per day on this basis is 5,100,000 cubic feet, and for the entire supply, this amount added to loss by evaporation, &c., 5,984,000 cubic feet, making a total of 11,084,000 cubic feet daily, or 128 cubic feet per second.

Mr. Low found by observations at the time of his survey, 1870, that the discharge of Rock River at Dixon was 2,446 cubic feet per second, "at a time, October 11, 1870, when, according to the residents of that city, the river was at its lowest known stage" (see Report of Chief of Engineers, 1871, pages 304 and 305); and I am informed by the proprietors of the Dixon Mills and other reliable residents of the town that so low a stage has not been reached since. Assuming this, of which 128 cubic feet is 5.2 per cent. as the least discharge, we have a maximum of 5.2 per cent. loss to the pool on account of the canal supply, with a certainty of considerably less in ordinary low-water seasons.

It should be remarked that this abstraction from Rock River can be lessened to any desired extent by utilizing other sources of supply along the main line.

Portions of the great swamp area, as traversed between Green and Rock rivers, could be transformed into large storage lakes at a small cost, sufficient to supply the entire reach between those rivers. A dam from 10 to 15 feet high across Green River at New Bedford would form a lake covering much of the Winnebago swamp area, and provide a storage for a large proportion of the rainfall tributary to the Upper Green River Basin. Also a limited supply could be obtained from West Bureau and East Bureau creeks.

MAIN LINE TO WATERTOWN.

Before the survey of the first main line had been completed I received your telegraphic instructions, on November 7, to make a resurvey of the line located by Mr. Gorham P. Low in 1870, under the direction of Col. J. N. Macomb, United States Engineer Corps, from the feeder junction to Watertown, on the Mississippi River; also, to run a line to Rock Island, by way of Rock River.

At once a new party, with General Charles A. Gilchrist in charge, was organized, partly from the scattered members of his former party, with a heavy draft upon the force then completing survey of the Marais d'Osier Route. This party took the field Novem-

ber 13, when, General Gilchrist being called away temporarily, Mr. Joseph G. Gilchrist took charge, with Mr. C. D. Hill topographer and Mr. Duane Pennock leveler.

Commencing at the feeder junction, the line follows, as nearly as practicable, from the meager tracings and reference marks, the route formerly surveyed, crossing to the south side of Hickory Creek Valley, thence across Coal Creek in a westerly direction, over a comparatively level country and good working ground, passing about a mile north of Mineral, Annawan, and Atkinson, and striking Green River at the forty-sixth mile, estimating from the Illinois River. On account of the great drainage from the south towards Green River, the cost for culverts in this reach, and for some miles further westward, is excessive. To provide for flood-waters of the two branches of Mud Creek, crossed at the thirty-fifth and thirty-seventh miles, an arrangement of weirs and guard-gates is provided to carry these streams across the canal during high water, when the culverts for the passage of ordinary stages are insufficient.

Spring Creek, at the forty-third mile, is crossed on an aqueduct 120 feet long. Continuing in the near vicinity of Green River, the line passes 2 miles north of Geneseo at the forty-ninth mile, entering a long stretch of almost continuous sand from the fiftieth to the fifty-seventh mile, requiring a lining of concrete through a greater portion of the distance. The Y tracks for a railroad siding to Cable's coal mine are crossed just before reaching Green River Station at the fifty-seventh mile, requiring two pivot bridges and a raise of 2 feet in the grade; also some rock excavation is met with here, as shown by the open work of the coal diggings near by, necessitating a lining of concrete to close up seams in the slaty rock.

At Green River Station a pivot highway bridge will be necessary on account of the difficulty in making an approach from the north to an elevated fixed bridge. Continuing from this point contiguous to the Chicago, Rock Island and Pacific Railway, and in heavy embankment, the route crosses Green River near the fifty-eighth mile on an aqueduct 400 feet long, passes through the town of Colona in a deep cut, crossing a branch of the Chicago, Burlington and Quincy Railway at the fifty-ninth mile, requiring a pivot bridge; thence with a sharp turn northward and another to the west, all within a mile, Rock River is crossed on an aqueduct 1,500 feet long, approached by long embankments on either side. The Colona hill being on a substratum of gravel, concrete lining is provided.

Between Rock River and the Mississippi, a rather low, flat depression is followed to Watertown, about 8 miles above Rock Island, crossing the Rock Island branch of the Chicago, Burlington and Quincy Railroad at the 63d mile and the Racine branch of the Chicago, Milwaukee and Saint Paul Railroad at the 64th mile, requiring at each a pivot bridge. The Mississippi is entered through a lock of 10 feet lift, with walls and tail gate 2 feet higher than extreme high water. To reach the main channel an excavation of about 2 feet in depth must be made in the rocky bed of the river, a distance of nearly a mile around the lower end of Campbell's Island. This will secure only 4 feet depth at extreme low water instead of 7, as is provided in other portions of the canal. As the channel depth over the "rapids" is reduced to about 4 feet at low-water stage, to secure a canal depth of 7 feet at such stage may be regarded as impracticable in this vicinity. There being no safe harbor for boats in the river at this locality, a basin with guard gates and weir is provided between the railway and river bank. Total length of line is 65.2 miles.

The latter part of this survey was prosecuted under somewhat adverse circumstances. The season being well advanced into the winter, cold winds and snow were prevalent. The field work closed December 28.

Only 48 miles of main line was considered in the determination of maximum quantity of water to be supplied by the feeder branch, as 15 miles of the route *via* the Marais d'Osier is supplied from Rock River. For the route now under consideration 63 miles must be maintained by the feeder, or 15 miles more than in the former case. In the former calculation it was found that the loss by evaporation, leakage, and percolation was 70,400 cubic feet per mile daily; hence an additional supply of 70,400 by 15 = 1,056,000 cubic feet daily will be demanded from the feeder, or 12 cubic feet per second, which added to 158 cubic feet (the amount required for the Marais d'Osier line) gives 170 cubic feet per second. This requires a mean velocity of $\frac{170}{4\frac{1}{2}} = 0.675$ feet per second in the feeder, and, estimating as for the first line, would require 5.7 per cent. of Rock River discharge at extreme low-water stage.

MAIN LINE TO ROCK ISLAND.

This route branches off southwardly from the Watertown line at the 58th mile, crossing the Chicago, Rock Island and Pacific Railroad, and entering the bed of Green River before the 59th mile is reached, follows its channel to Rock River, thence down the latter to Milan, and across the low point of land south of Rock Island to the Mississippi at a point one-half a mile south of the Rock Island corporation line, and 74.5 miles from the Illinois River.

Although coincident with the other route in alignment from the 57th to the 58th

mile, its elevation is 10 feet lower, avoiding the heavy embankment necessary in the other line to cross Green and Rock rivers above high-water mark. A pivot bridge is required at the crossing above mentioned; also near the 60th mile, where a branch of the Chicago, Burlington and Quincy Railroad crosses Green River. Two highway bridges, one near the railroad bridge, the other at the 59th mile, must be raised and renewed.

The navigation of Green and Rock rivers is made feasible by a succession of pools formed by two new dams, and raising the existing ones at Milan about 3 feet. The first dam is on Green River near the 59th mile, where a lock of 5 feet lift is provided, the second on Rock River at the 65th mile, with a lock of 5 feet lift. These dams will cause a submergence of several hundred acres of low land, which item has been considered in the estimate for damages. It is supposed that the construction of a protecting dike from the Milan dam up-stream about a mile, on the left bank, will prevent any further submergence on account of raising the dams. A highway bridge near the 68th mile, will require construction of heavier piers to carry the bridge at a higher elevation than at present, to secure sufficient head room for boats.

Leaving the river at the north dam at Milan, the line enters and follows for a quarter of a mile, what is known as Sear's Canal; of sufficient dimensions at the upper end, but requiring an enlargement at the lower end, and a guard lock. Also, two pivot bridges are required here, one to carry the highway and street car tracks, the other on the line of the Peoria and Rock Island Railroad.

In rounding the bluff after leaving Sear's Canal, some rock excavation is necessary and the cutting is heavy for a distance of nearly a mile. Concrete lining is provided in rock excavation. Two locks of 8½ feet lift each, at the Mississippi River, drop the canal bottom to 7 feet below low water. No basin has been estimated for at this terminus, as it is supposed a good harbor can be found at the foot of Rock Island.

It should be remarked that but few soundings were taken in Rock River, the ice not being strong enough to support a man, but sufficient to prevent the use of a skiff; hence the bottom line as shown on accompanying profile is to a great extent imaginary, though sufficiently accurate for the object in view.

On account of the frozen condition of the ground and a covering of snow at the time of surveying the latter part of this route, the nature of the soil may differ from that assumed in the estimate of cost.

The distance from the Illinois to Green River by this line being 10 miles greater than that from the Illinois to Rock River by the Marais d'Osier route, an additional water supply sufficient to provide for loss from evaporation, &c., for 10 miles of canal, must be drawn from the feeder. This equals $70,400 \text{ by } 10 = 704,000$ cubic feet daily, or 8.1 cubic feet per second, requiring a total of $158 + 8 = 166$ cubic feet per second, a mean velocity in feeder of 0.659 foot per second, and an abstraction of 5.5 per cent. from extreme low-water discharge of Rock River at Dixon.

LIFT LOCKS.

The lift locks proposed have a chamber area of 170 by 30 feet, with a height of lift varying from 6 to 11 feet. A single exception occurs in the last lock on the Marais d'Osier route, where the lift is 16 feet. In the estimate for cost of these, a timber and concrete foundation (in a few instances resting on piling) is contemplated. The chamber walls to be of dressed masonry, backed with concrete, with a sluice-way through the backing for passing water from the upper to the lower level, to supply the lock chamber, and to operate a turbine wheel for maneuvering boats through the lock. The gates to be of timber and operated by hand-power. There is included in the estimate for each lock a house for lock tender.

From the Illinois River to the summit level there are twenty-three locks in a distance of 18 miles, aggregating a total lift of 205 feet and averaging 11.4 feet per mile. From the summit level to the Mississippi by the Marais d'Osier route there are eight locks, aggregating 75 feet lift; by the Watertown route, nine, aggregating 86 feet; and by the Rock Island route, twelve, aggregating 101 feet lift.

The location of the locks is given on the maps of the different routes, and the lift of each is indicated on the profiles.

CULVERTS.

The necessary culverts are quite numerous on that portion of the line east of the feeder junction, being forty-two in number, while only twenty are required on the western slope of the Marais d'Osier route and forty-six and forty-nine on the same slope of the Watertown and Rock Island routes respectively. This disparity in their frequency on the two slopes of the first line is due to the fact that the eastern slope lies mainly in a valley, into which the adjacent country sheds its rainfall, while the western slope lies, to a great extent, on a dividing summit which turns the drainage from or parallel to the line rather than towards it.

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The great drainage area south of and tributary to Green River necessitates heavy culvert construction on the Watertown route, from the feeder to the Green River crossing.

They vary in size from the simple box to archways of 150 square feet opening, and are of masonry, on a concrete and timber foundation. The desirability of constructing the canal in excess of excavation rather than embankment places its bottom so low that a majority of the culverts are of the inverted siphon form. This is notably the case on the feeder branch.

WEIRS.

Waste-weirs of masonry are provided for discharging surplus water from the different levels and for draining them when required. Similar provision is made on the feeder branch at the 11th mile and at Green River. Where levels are short, as in many instances on the eastern slope, the arrangement for drainage is omitted in some of them. Special weir constructions are necessary on the feeder branch to take in the water from a depression called Swan Lake at the 16th mile, and to discharge it about a mile below. A similar arrangement is provided to take in the water from an old lake (now partially drained by a ditch) near the eastern end of the summit level.

BRIDGES.

Bridges are only provided for carrying public highways and railroads over the canal. Private and farm roads are considered in the estimate for damages. All superstructures are of iron, resting on stone piers and abutments and placed at a minimum height of 15 feet from surface of water in canal to bottom of lower chords of bridges. The span is ordinarily 72 feet, except where the bridges can be conveniently placed on the prolongation of lock walls, when the span is 30 feet.

The number of highway bridges on the Marais d'Osier route is thirty-six, on each of the other two routes, forty, and twenty-one on the feeder branch. All highway bridges are fixed, except the following: one at the Mississippi, on the Marais d'Osier route, where a pivot with two draws of 50 feet each is necessary to pass boats during high water only. Two on the Watertown route, one of which is at Green River station, the other in the town of Colona, and one on the Rock Island line, crossing Sear's Canal near Milan.

Of the five railroad bridges on the Marais d'Osier route, three are pivots, and that on the Racine branch of the Chicago, Milwaukee and Saint Paul Railroad, near the Mississippi River, has two draws of 50 feet each, to be opened only during high water. On each of the other routes six of the seven railroad bridges required are of the pivot form. The feeder branch requires two fixed and three pivot bridges for railroad crossings.

AQUEDUCTS.

To give free passage for boats such as the locks could accommodate, a width of 36 feet was adopted for the water-way in all aqueducts. They consist of a wooden trunk resting on piers 22 feet apart usually, but are placed 50 feet apart where there is room beneath for special trussing. Their lengths at the different localities are given previously in this report.

RIGHT OF WAY AND SPECIAL DAMAGES.

To include within its limits the slopes of the canal generally, I have assumed 180 feet as the necessary width of the right of way. In making the survey valuable property was avoided where an equally good location could be had on less costly ground. But few buildings of importance are included in the right of way, except at the town of Colona, though damage would result to much property in close proximity to the canal in shutting off the present access thereto. A valuation of from \$10 to \$100 per acre has been placed upon the land covered by the proposed right of way, and allowance made for contingent damages.

The Chicago, Rock Island and Pacific Railroad right of way has not been encroached upon except at the crossing at Lepertown, and again where the Rock Island route crosses it, near Green River, though the canal right of way has been made contiguous to that of the railroad for a number of miles on the eastern slope, and again from the 53d to the 59th mile on the Watertown route. This contiguity was necessary in many instances, though frequently adhered to in order that a narrow strip of land might not be inclosed between the railroad and canal right of way.

As before suggested a much better profile and cheaper construction would result at several points by intrenching upon their right of way, and especially would this obtain were the track itself moved in some instances; as at points in the Bureau Creek Valley in the vicinity of Pond Creek Station, from Green River Station westward half a mile, and at Colona. As the damage that would result from such interference would probably more than cover the advantage to construction, any other encroachment

upon railroad right of way than that incidental to crossing their line has been avoided' and the crossings are reduced to a minimum for the different routes.

It should be noted here that no allowance has been made in the estimate for damages which would result from the introduction of a pivot bridge into a railroad line.

FENCING.

A barbed wire fence with five wires and cedar posts is provided for both sides of the canal, except where contiguous to a railroad, when one side will suffice.

PREVENTION OF LEAKAGE.

As previously stated, the greater portion of each route, and the feeder branch, is located in favorably-conditioned soil, in the matter of securing a reasonably impervious bed for the canal. Not only is a soil rich in clay predominant, particularly on the western slope, but many miles of the Marais d'Osier route lie in a permanently saturated, marshy soil, where any leakage through the bottom at least is absolutely impossible. The same is true of several miles of the Watertown route immediately west of the feeder junction, and through almost half the length of the feeder branch. Where the excavation is in sand or gravel, a special lining of some water-tight material must be provided. Different materials have been used for this purpose in canal construction with a good degree of success. The most satisfactory, and in the long run the cheapest, is probably a lining of concrete about 6 inches thick on the bottom, and extending up the side slopes to the watersurface, gradually diminishing in thickness to the top, where 4 inches will suffice. A layer of earth at least 10 inches thick should be laid over the concrete to protect it from possible shocks and breakage. In the estimate of cost a lining of this character is provided in the gravel formation at several points in Bureau Creek Valley, through several miles of sand on the Watertown line between Geneseo and the Green River crossing, and at several other points of minor importance on the different lines.

In all cases where the water surface in the canal is above the natural surface of the ground, a vertical wall of puddling, with its base extending below the natural surface, and to be carried up with construction of the embankment, is necessary. No special estimate is made of this item, as material for the puddle is plentiful along the line, and its cost will be but little in excess of ordinary embankment construction.

PROTECTION OF SLOPES.

Riprap is provided in all cases where the outer slope would be subject to wash from an adjacent water-course. The principal localities requiring this protection are along Bureau Creek, at several reaches along Green River, on the Watertown line, and along Rock River on the feeder branch. For the latter stone could be obtained from the rocky bluff on the river bank at the fifth mile; for the Bureau Creek region the Joliet quarries would probably be the most accessible, while the Green River country could be supplied from the vicinity of Cable's coal mine, near Green River station.

No protection for the inner slopes is estimated for, as it is impossible to decide where it will be necessary until construction is under way. Although a complete paving of these slopes, from bottom to top, would be necessary to protect them permanently from washing, it is a question whether a cleaning out from time to time of the material carried from the slopes to the bottom, would not answer every purpose. Evidently where the canal is in embankment much deterioration of this kind would eventually destroy the bank, and some protection would be necessary if erosion were excessive.

BENCH-MARKS.

Distinctly marked benches were established, at intervals of about a mile, on all the lines surveyed. Trees were usually the most permanent objects upon which to place them, though stone walls and abutments were used when practicable. These benches are all located and numbered on the accompanying maps.

MAPS.

The maps accompanying this report are on a scale of 1 inch to 400 feet, and show the transit lines run, topography of the country traversed (in the near vicinity of the lines), location of bench-marks, proposed location of the canal, and the location and number of lift-locks.

It will be observed that the located line deviates materially from the transit line in many instances. By a system of cross levels and full topography notes, this deviation is made without impairing the accuracy of the estimate for cost of construction.

In addition to the above maps, a reference map on a smaller scale is submitted, showing the location of the lines surveyed. On this map is also shown, in elevation, the proposed arrangement of levels on each route.

PROFILES.

The accompanying profiles show the elevation along the different located lines, and are all referred to the same datum plane taken 10 feet below the surface of the Illinois River at the eastern terminus of the lines as found at the time of the survey, September 16, 1882. From information from residents, and from the fact that the above date is about the middle of the low-water season, I assumed the observed elevation as that of low-water stage. The elevation of high water was taken from a mark on a warehouse in Hennepin, said to be the high-water mark of 1844. The low-water surface of the Mississippi at the Marais d'Osier terminus was adopted after inquiry of residents of Comanche, opposite, and of Albany, 2 miles above. There being no water-gauge in the vicinity, I was restricted to this rather uncertain information. For the high and low water elevations at the western terminus of the other two routes, as referred to the gauge at Rock Island, I am indebted to the United States engineer office at Rock Island. Connection being made between our levels and the Rock Island gauge, the elevations of high and low water at the points named were readily transferred to the Hennepin Canal levels. They are given on the profiles.

ESTIMATE OF COST.

Detailed estimates for cost of construction are given for each mile section for each route, and the feeder branch, on the four estimate sheets herewith.

In order to condense these somewhat, the price and quantity of materials are not generally given. I note below the prices used for some of the principal material, to wit:

	Per cubic yard.
Dressed masonry	\$13 50
Rubble masonry	10 00
Paving	6 00
Riprap	3 00
Concrete	6 00
	Per M feet, B. M.
Timber, oak	\$60 00
Timber, pine	40 00
Timber, hemlock	30 00

It is presumed that all the stone for dressed masonry would be supplied from the quarries at Joliet, Ill., as would the lower grades of stone for the eastern end of the work. In the vicinity of Rock Island the lower grades could be had in abundance, and some could be supplied from the vicinity of Cable's coal mines on Green River. The gravel and sand so prevalent on portions of the line could be utilized in making concrete. The prices for stone and concrete are based on the above facts.

Reference to the estimate sheets shows a marked difference in the cost per mile on different portions of the routes. For example, the first 25 miles from the eastern terminus averages \$98,074.77 per mile, while from the feeder junction to the Mississippi, on the Marais d'Osier route, the cost is only \$43,360.12 per mile. On the Watertown and Rock Island routes, from the same point to the Mississippi, the figures are \$76,906.97 and \$51,654.62 per mile, respectively, and on the feeder branch \$44,854.42.

The following statement gives the comparative estimated cost of the three routes:

Comparative estimates of cost of the three routes.

Subject of expenditure.	Marais d'Osier.	Watertown.	Rock Island.
Earthwork	\$1,024,808 75	\$1,142,367 95	\$1,023,844 75
Lift locks	1,393,350 50	1,435,690 23	1,605,270 00
Culverts	184,262 03	318,021 09	340,231 09
Weirs	89,964 15	46,109 20	108,165 10
Bridges, railroad	35,942 54	57,851 54	68,919 54
Bridges, highway	150,497 75	167,180 25	180,500 25
Aqueducts	391,212 81	736,713 39	327,339 39
Concrete	133,056 00	376,992 00	376,992 00
Right of way	134,050 00	132,820 00	143,530 00
Fencing	37,600 00	37,142 00	36,960 00
Special work	180,482 72	588,704 50	238,617 92
Total	3,770,227 25	5,039,572 15	4,553,430 14
Contingencies, 10 per cent	377,022 73	503,957 21	455,343 01
Aggregate	4,147,249 98	5,543,529 36	5,008,773 15
Feeder branch	1,664,117 52	1,664,117 52	1,664,117 52
Total	5,811,367 50	7,207,646 88	6,672,890 67

LIST OF MAPS, PROFILES, AND ESTIMATE SHEETS.

The following maps, &c., are submitted herewith, viz:

- (1.) A map, on a scale of one inch to 2 miles, showing location of the three routes and feeder branch; and profiles of the proposed levels on the different routes.
- (2.) Topographical map, on scale of one inch to 400 feet, showing lines of survey and location, and comprising the following eight sheets:
 Sheet A.—From the Illinois River to the feeder junction.
 Sheet B.—From the feeder junction to Rock River on the Marais d'Osier route.
 Sheet C.—From Rock River to the Mississippi on the Marais d'Osier route.
 Sheet D.—From the feeder junction to Spring Creek on the Watertown route.
 Sheet E.—From Spring Creek to Mississippi River on the Watertown route.
 Sheet F.—From Green River Station to the Mississippi River on the Rock Island route.
 Sheet G.—From Dixon to the 20th mile on the feeder branch.
 Sheet H.—From the 20th mile on the feeder branch to the main line.
- (3.) Profiles of the different located lines, including the following five sheets:
 Sheet No. 1.—From the Illinois River to the feeder junction.
 Sheet No. 2.—From the feeder junction to Mississippi River on the Marais d'Osier route.
 Sheet No. 3.—From the feeder junction to Mississippi River on the Watertown route.
 Sheet No. 4.—From Green River Station to Mississippi River on the Rock Island route.
 Sheet No. 5.—The feeder branch.
- (4.) Tabular statements of the estimated cost for construction, in mile sections, of the three routes and feeder branch separately, on four sheets.

CONCLUSION.

The information resulting from the surveys indicates that either of the routes, for a canal of the proposed dimensions with a water supply from the feeder branch, is entirely feasible in so far as construction is concerned, if we except the impracticability of obtaining an entrance, of 7 feet depth, to the Mississippi at Watertown.

That the Marais d'Osier route has the advantage as to first cost over either of the others; and that this route, traversing about 26 miles of constantly saturated soil, west of the feeder junction, presents an economy in leakage through its bottom not enjoyed by either of the other routes. Other characteristics of minor importance in determining "the most practicable and convenient route" might be mentioned, but one of the leading considerations in deciding upon the proper route being with reference to commercial rather than engineering advantages, I make no further comparisons.

Before closing this report I wish to note my appreciation of the able and zealous manner in which the gentlemen in charge, as well as each member of the survey parties, performed the duties assigned them, and to acknowledge the diligent and skillful assistance rendered by the Engineers employed in the preparation of the estimates for cost of construction, and the maps and profiles herewith.

I have the honor to be, very respectfully, your obedient servant,

H. B. HERR,
Assistant Engineer.

To Maj. W. H. H. BENYAURD,
Corps of Engineers, U. S. A.

SURVEY AND ESTIMATES FOR ENLARGEMENT OF THE ILLINOIS AND MICHIGAN CANAL.

REPORT OF MR. GEORGE Y. WISNER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., January 22, 1883.

MAJOR: I have the honor to submit the following report of survey and estimates for enlargement of the Illinois and Michigan Canal, from Chicago to the Illinois River at La Salle.

In compliance with your instructions of October 3, 1882, I have made a careful survey of the canal, and determined cross-sections at intervals of 500 feet throughout its entire length.

These cross-sections have been platted, and may be utilized for computing cost of enlargement in case any other size of prism of canal should finally be adopted than that now proposed.

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The canal property consists of a strip of land 240 feet in width (90 feet each side of canal) with a few exceptions through villages and across the sixteenth sections of townships.

For about 15 miles from Chicago the cutting for canal is principally through clay, and for a larger portion of the next 20 miles the canal is cut through limestone rock. The remainder of the route is through clay and sand loam, with occasional beds of rock and gravel.

A large amount of material needed for construction may be obtained on the canal property, which, with the extensive quarries adjacent to the canal near Lockport, renders the cost of enlargement very reasonable. The present canal is a little over 60 feet wide at surface, and of irregular section, averaging about 390 square feet sectional area.

The locks are 110 feet long, 18 feet wide, and 6 feet deep on miter sills.

The following estimates have been made for prism of canal similar in size to that proposed for the Hennepin Canal, viz: 80 feet wide at surface, 59 feet wide at bottom, and 7 feet deep, with locks 170 feet long, 30 feet wide, and 7 feet deep on miter sills. The sectional area will be 485 square feet, or about 25 per cent. larger than that of present canal.

The new pumping works now being erected at Bridgeport are expected when completed to deliver in canal about 1,000 cubic feet of water per second, which will make a mean velocity of current in the present section of canal of about 1.7 miles per hour, and for the proposed section 1.4 miles per hour. With a loaded boat occupying a large portion of this cross-section, the current will be much too heavy for economy of transportation, and if the canal is to be used as an outlet for Chicago sewage, I think the prism should be made much larger than that now proposed.

The water supply for the present canal will be ample. No survey was made of the feeders, but from information obtained I think they are in about the same state of repair as the present canal.

It is expected to obtain the increase of depth in canal from Chicago to the Du Page River by dredging, but from the Du Page River to La Salle it will be much more economical to raise the height of water in the levels 1 foot, thus saving a large amount of excavation. The excavation being in excess of the amount of embankment required, no extra expense will be incurred by raising the banks.

No changes have been made in the location of locks. The estimates for material in locks have been made for cut stone for face of walls and culverts, and uncut stone for remainder of masonry.

Feed culverts are to be built through the lock walls, for regulating the flow of water in canal, and the foundations to be of concrete, except where lock walls are built directly on the native rock. The aqueducts on the line at present have wooden trunks about 24 feet in clear width, supported on stone abutments and piers.

Estimates have been made for repair of masonry and for new trunks to correspond in size with the proposed enlargement.

All bridges less than 15 feet in the clear above water in the canal should be raised. The abutments for several of the bridges will have to be rebuilt.

The stone arch culverts under the present canal will need no alterations, but there are twelve wooden box culverts which should be replaced by stone ones.

Through sand, loam, and gravelly soils slope walls will be required to protect the banks from caving. The canal should also be fenced for a greater part of its length.

Estimates have been made for waste-weirs with gates at Lockport and at Marseilles, which, with surface weirs on the longer levels for escape of water from heavy rains, will be sufficient for regulating the height of water in canal. The dams in Des Plaines River at Joliet, and in the Du Page River, will need no repairs at present.

The accompanying profile shows the elevation of ground with reference to water surface of present canal. The curves showing the amount to be excavated are plotted from ordinates representing the number of square yards in the respective sections. The mean ordinate for any section multiplied by the length of section in yards will equal the number of cubic yards of excavation required.

There are seventeen locks and watchmen's houses belonging to the canal property, nine of which have been built within the past five years, and the others have been recently repaired.

I am under obligations to Mr. Wm. Thomas, Superintendent of Illinois and Michigan Canal, for valuable information furnished from the canal office, and also to Mr. John Ericson for able assistance in both field and office work.

Very respectfully submitted.

GEO. Y. WISNER,
Assistant Engineer.

Maj. W. H. H. BENYAURD,
Corps of Engineers, U. S. A.

Detailed estimate for locks.

Number of locks.	Lift of locks.	Rolling and draining.	Removing old tim-ber.	Excavation.			Embankment, at 20 cents.	Lining, at 50 cents.	Pudding, at 25 cents.	Paving, at \$3.	Masonry.				Concrete, at \$5.
				Earth, at 25 cents.	Rock, at \$1.75.	Old masonry, at \$1.50.					Cut stone, at \$12.	Uncut stone, at \$3.	In culverts, at \$12.	Vertical walls, at \$5.	
	Feet.			cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.
1.....	10	\$500	\$100	3,600	275	1,840	3,300	200	225	60	820	1,890	100	420	390
2.....	10	500	100	3,600	275	1,840	3,300	200	225	60	820	1,890	100	420	390
3.....	10	500	100	3,600	275	1,840	3,300	200	225	60	820	1,890	100	420	390
4.....	10	500	100	3,600	275	1,840	3,300	200	225	60	820	1,890	100	420	390
5.....	10	1,200	100	3,600	275	1,840	3,300	200	225	60	820	1,890	100	420	390
6 (guard).....	0.5	1,000	100	2,300	275	1,840	2,000	200	225	60	820	1,890	100	420	390
7.....	12	1,000	100	4,700	275	2,050	4,500	150	225	60	430	2,140	100	270	390
8.....	8	1,200	100	3,200	275	1,250	1,700	200	300	60	950	2,140	100	440	330
9.....	6.5	500	100	2,950	250	1,500	2,100	200	300	60	550	1,180	100	400	330
10.....	8.5	500	100	3,300	250	1,690	2,000	200	225	60	690	1,180	100	410	390
11.....	8.5	500	100	3,300	250	1,690	2,000	200	225	60	780	1,650	100	410	390
12.....	10	500	100	3,600	250	1,730	2,300	200	225	60	820	1,890	100	420	390
13.....	9	500	100	3,730	250	1,840	2,300	200	225	60	800	1,890	100	420	390
14.....	6.5	500	100	2,850	250	1,500	2,100	200	325	60	650	1,460	100	410	390
15.....	12.5	500	100	4,700	250	2,250	4,500	200	325	60	970	2,250	100	450	390
16.....	12	1,200	100	4,700	250	2,010	4,400	200	325	60	950	2,140	100	450	390
Total quantities.....				57,890	2,650	27,580	43,730	3,150	4,175	960	12,450	27,860	1,600	7,000	8,860
Total cost.....		\$11,100	\$1,600	\$14,457 50	\$4,637 60	\$41,370	\$9,746	\$1,575	\$1,043 75	\$2,880	\$148,400	\$167,160	\$19,200	\$35,000	\$44,400

Detailed estimate for locks—Continued.

Number of locks.	White-oak timber and plank, at \$40 per 1,000 feet.	Pine timber and plank, at \$40 per 1,000 feet.	Subbing post, at 50 cents per linear foot.	Iron.			Lead, at 12 cents.	Painting.	Value of material in old locks.	Amount.
				Wrought, at 10 cents.	Cast, at 7 cents.	Spike, at 5 cents.				
	Feet, B. M.	Ft., B. M.	Lin. ft.	Pounds.	Pounds.	Pounds.	Pounds.			
1.	15,000	3,000	100	7,100	5,500	300	200	\$80	\$6,000	\$28,431 50
2.	15,000	3,000	100	7,100	5,500	300	200	60	6,000	28,431 50
3.	15,000	3,000	100	7,100	5,500	300	200	60	6,000	28,431 50
4.	15,000	3,000	100	7,100	5,500	300	200	60	6,000	28,431 50
5.	15,000	3,000	100	7,100	5,500	300	200	60	6,000	31,201 50
6 (guard)	9,600	3,000	100	6,500	5,500	300	200	40	2,700	17,648 50
7.	15,100	3,000	100	7,200	5,500	300	200	65	6,500	33,948 25
8.	11,000	3,000	100	6,700	5,500	300	200	45	4,100	23,548 00
9.	11,500	3,000	100	6,900	5,500	300	200	50	5,000	23,978 25
10.	14,000	3,000	100	7,000	5,500	300	200	55	5,600	26,382 75
11.	14,000	3,000	100	7,000	5,500	300	200	55	5,600	26,382 75
12.	15,000	3,000	100	7,100	5,500	300	200	60	6,000	28,387 75
13.	15,000	3,000	100	7,100	5,500	300	200	55	5,800	28,212 75
14.	12,500	3,000	100	6,900	5,500	300	200	50	5,000	25,845 75
15.	15,000	3,000	100	7,300	5,600	300	200	60	7,000	34,508 25
16.	15,100	3,000	100	7,200	5,500	300	200	65	6,500	34,016 25
Total quantities	224,300	48,000	1,600	112,300	87,100	4,800	3,200	-----	-----	-----
Total cost	\$18,468	\$1,920	\$800	\$11,230	\$5,097	\$240	\$384	\$800	\$89,800	\$448,804 75

Detailed estimate for section work.

No. of section.	Excavation.		Slope and vertical wall at \$1.50.	Fencing at \$300 per mile.	Puddling at 25 cents.	Repair of abutments and raising of bridges.	Amount.
	Earth at 20 cents.	Rock at \$1.75.					
	Cu. yds.	Cu. yds.	Cu. yds.	Miles.	Cu. yds.		
1	13,193			2			\$3,238 60
2	17,330			2			4,066 00
3	18,712			2		\$400	4,742 40
4	28,083			1.5		400	6,466 80
5	27,053			1			5,710 60
6	22,935			1			4,887 00
7	22,589			1			4,817 80
8	17,526			1		*2,500	6,305 20
9	17,767		1,020	1			6,733 40
10	32,434		3,910	1			12,651 80
11	20,987		3,910	1			10,362 40
12	21,428		3,910	1		*2,500	12,950 60
13	25,377		3,910	1		400	11,640 40
14	34,449		3,910	1			13,054 80
15	50,002	387	3,910	1			16,842 65
16	27,791	21,918	300			400	44,764 70
17	27,952	10,698					24,311 90
18	28,530	13,410	1,000	1.5			31,123 50
19	20,444		3,700	2			10,238 80
20	7,080	31,706	400				57,501 50
21	985	40,523				200	71,314 20
22		27,159					47,528 25
23	3,461	34,608				400	61,656 25
24	9,626	29,961					54,356 90
25	10,554	82,334					58,695 35
26	12,289	84,702					63,186 30
27	10,412	30,402	2,280				58,705 90
28	21,045	6,696	3,910	2			22,392 00
29	15,873	2,164	3,910				12,826 60
30	7,643	7,132	3,660				19,499 60
31	34,617		3,910	2			13,388 40
32	29,099	10,641	3,570	2			30,396 50
33	26,722	3,313	2,300				14,502 15
34	8,404	2,281				400	6,072 35
35	18,491	24,483	3,910		400	*8,500	56,008 45
36	11,516	10,270	2,200	2	1,500	400	24,950 75
37	6,232		2,640	2	3,600		6,706 40
38	2,646		1,900	2	3,600		4,879 20
39	4,569		1,900	2	1,000	400	5,013 80
40	23,641		3,550	2	3,600		11,553 20
41	21,589		3,910	2	3,600	\$400	\$12,082 80
42	28,794		3,910	2	3,600		13,123 80
43	15,707		2,980	1.5	100		8,011 40
44	6,259		1,950	1			4,476 80
45	19,557		3,900	0.5	3,600	500	11,311 40
46	24,814		3,100	1.5	700	1,750	11,987 80
47	9,318		3,910	2	500		8,453 00
48	17,107		3,910	1	1,200		9,886 40
49	11,075		3,910	1	3,600		9,280 00
50	9,656		3,910	1	1,400		8,446 20
51	13,809		2,820	2	3,000		7,591 80
52	26,302		3,550	2	800	1,750	13,535 40
53	16,256		2,680	2	500		7,996 25
54	30,057		3,370	2	900	1,750	12,641 40
55	25,828		3,910	2			11,630 60
56	23,723		3,910	2	3,000		11,959 60
57	27,596		3,910	2	3,600		12,944 20
58	21,193		3,910	2	1,000	1,750	12,703 60
59	18,654		3,100		600		8,530 80
60	19,215		3,000	1	3,200	1,750	11,193 00
61	20,852		3,910	2	3,500	1,800	13,310 40
62	23,021		3,910	2	3,300		11,894 20
63	23,242		3,910	2	500		11,238 40
64	19,807		3,910	2	400		10,526 40
65	24,634		3,910	2	600	1,800	13,341 80
66	25,615		3,910	2	600		11,738 00
67	24,897		3,910	2			11,444 40
68	33,902		3,910	2	800		13,445 40
69	23,924		2,680	2	1,000		9,654 80
70	35,466		3,200	1		1,700	13,893 20
71	31,665		3,910	2	600		12,948 00
72	34,971		3,910	2	700		13,634 20
73	28,030		3,910	2	1,000		12,321 00
74	23,576		3,800	2	300		11,090 20
75	20,410		3,200	1		1,700	10,882 00

* Railroad.

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Detailed estimate for section work—Continued.

No. of section.	Excavation.		Slope and vertical wall at \$1.50.	Fencing at \$300 per mile.	Puddling at 25 cents.	Repair of abutments and raising of bridges.	Amount.
	Earth at 20 cents.	Rock at \$1.75.					
	<i>Cu. yds.</i>	<i>Cu. yds.</i>	<i>Cu. yds.</i>	<i>Miles.</i>	<i>Cu. yds.</i>		
76	28,981		3,910	2	500	\$1,750	\$14,126 25
77	4,234		1,950	2	200		4,421 00
78	18,148		3,910	2	300		10,160 00
79	26,906		3,910	2			11,846 25
80	31,745		3,910	2			12,814 00
81	25,172		3,910	2		1,750	13,249 44
82	7,492		950	1			3,223 40
83	9,683					1,750	3,636 00
84	22,261		3,600	2		1,800	12,253 25
85	16,522		3,900	2	300		9,829 44
86	12,777		2,680	1	600	1,750	8,775 44
87	17,213		3,180	1			8,512 00
88	7,049		1,950	1	200		4,054 00
89	10,378		2,680	2	300		6,770 00
90	24,831		3,910	2	200		11,481 25
91	31,260		3,910	2	300		12,732 00
92	23,037	6,147	3,700	1	400	1,750	23,064 65
93	12,503		3,910	1	400		5,765 00
94	22,672		3,100	1	200		9,534 44
95	23,743	2,890	1,800	1	300		11,986 19
96	21,483		3,800	1			10,256 00
97	12,856						2,571 20
97½	3,562						712 40
Total quantities	1,935,825	383,825	259,880	127.5	66,100		
Total cost	\$387,165	\$670,818 75	\$389,820	\$38,250	\$16,525	\$39,100	\$1,541,678 75

Estimated cost for aqueducts.

Location.	Removing old structure and repairing masonry.	Lumber and plank.		Iron.		Amount.
		Oak at \$60 per 1,000 ft., B. M.	Pine at \$40 per 1,000 ft., B. M.	Spike and nails at 5 cents per pound.	Wrought, at 10 cents per lb.	
		<i>Feet, B. M.</i>	<i>Feet, B. M.</i>	<i>Pounds.</i>	<i>Pounds.</i>	
Aux Sable River	\$1,000	69,700	24,400	700	4,900	\$6,663 00
Nettle Creek	500	25,000	8,700	300	1,750	2,538 00
Fox River	2,500	236,400	82,650	2,400	16,600	21,779 00
Little Vermillion River	1,200	89,600	31,900	900	6,300	8,503 00
Total quantities		420,700	147,050	4,300	29,550	
Total cost		\$25,242 00	\$5,882 00	\$21,500 00	\$2,955 00	\$39,494 00

Estimated cost for culverts.

[Length of chord, 4 feet.]

Items.	Price.	Amount.
Balling and draining, 12 culverts	\$200 00	\$2,400 00
Removing old timber	25 00	300 00
Excavation, 9,000 yards	per yard	20 1,800 00
Embankment, 7,200 yards	do	20 1,440 00
Masonry in arch, 720 yards	do	12 00 8,640 00
Masonry in walls, 1,260 yards	do	5 00 6,300 00
Masonry in concrete, 720 yards	do	5 00 3,600 00
Hemlock timber, 102,000 feet	*per 1,000 feet	30 00 3,060 00
Spike, 1,200 pounds	per pound	05 60 00
Total cost of culverts		\$27,600 00

Estimated cost for waste weirs.

[Waste weir at Lockport: Length, 100 feet; number of openings, 5.]

Items.	Price.	Amount.
Bailing and draining		
Earth excavation, 1,500 yards	\$200 00	\$200 00
Embankment, 300 yards	20	300 00
Puddling, 200 yards	20	80 00
Masonry in arch, 25 yards	25	50 00
Masonry in walls and abutments, 540 yards	12 00	300 00
Masonry in concrete, 200 yards	6 00	3,240 00
Paving, 100 yards	5 00	1,000 00
3,300 feet B. M. oak timber	8 00	300 00
4,000 feet B. M. pine timber and plank	60 00	198 00
10,000 feet B. M. hemlock timber	40 00	160 00
Wrought iron, 500 pounds	30 00	300 00
Cast iron, 1,500 pounds	per pound	10 50
Spike and nails, 200 pounds	07	105 00
	05	10 00
Total		6,273 00

[Waste weir at Marseilles: Length, 25 feet; number of openings, 3.]

Items.	Price.	Amount.
Bailing and draining		
Earth excavation, 300 yards	\$0 20	\$100 00
Earth embankment, 200 yards	20	80 00
Puddling, 100 yards	25	40 00
Masonry in arch, 15 yards	25	25 00
Masonry in walls and abutments, 175 yards	12 00	180 00
Masonry in concrete, 100 yards	6 00	1,050 00
Paving, 50 yards	5 00	500 00
Oak timber, 500 feet B. M.	3 00	150 00
Pine timber and plank 2,000 feet B. M.	per 1,000 feet	30 00
Hemlock, 8,000 feet B. M.	40 00	80 00
Wrought iron, 300 pounds	30 00	90 00
Cast iron, 800 pounds	per pound	10 80 00
Spike and nails, 100 pounds	07	51 00
	05	5 00
Total		2,396 00

[4 waste weirs; Length of each, 50 feet.]

Items.	Price.	Amount.
Bailing and draining		
Earth excavation, 2,000 yards	\$50 00	\$ 200 00
Embankment, 600 yards	20	400 00
Puddling, 400 yards	20	120 00
Masonry in walls and abutments, 600 yards	25	100 00
Masonry in concrete, 120 yards	5 00	3,000 00
Pine timber and plank, 10,000 feet B. M.	5 00	600 00
Hemlock, 28,000 feet B. M.	40 00	400 00
Spike and nails, 400 pounds	30 00	840 00
	per pound	05 20 00
Total		5,680 00
Total cost of waste weirs		14,349 00

Summary.

Items.	Amount.	Total.
Section work	\$1,541,678 75	
Locks	448,804 75	
Aqueducts	39,494 00	
Culverts	27,600 00	
Waste weirs	14,349 00	
Steam dredge	18,000 00	
		\$2,080,926 50
Add 10 per cent. for contingencies		208,992 65
Grand total		2,289,919 15

COMMERCIAL STATISTICS AND GENERAL CONSIDERATION OF THE BENEFITS TO BE DERIVED BY THE CONSTRUCTION OF THE CANAL BETWEEN THE MISSISSIPPI AND THE LAKES.

The construction of a canal to connect the waters of the Upper Mississippi with those of the lakes, by way of the Illinois and Michigan Canal, has long been earnestly desired by the people occupying the vast area lying west of Chicago and seeking improved channels of communication with that city and the East. Four times—in 1864, 1870, 1874, and 1882, respectively—has the general assembly of Iowa, by concurrent action on the part of each of its branches, specifically memorialized Congress for the opening of such a canal by the General Government. The legislature of Illinois has also similarly addressed its appeal to Congress repeatedly, the last occasion being that of the special session of that body last year. These two States, thus speaking through their representatives, embrace more than 5,000,000 of people. Their expression of opinion and desire have been earnestly supported, too, by resolutions adopted by such Boards of Trade as those of Saint Paul, La Crosse, Duluth, Davenport, Rock Island, and Chicago in the Northwest, and those of Buffalo, Syracuse, and New York in the East, and by the resolution of the senate branch of the New York assembly last May, which would have been concurred in by the house had the session had two days longer continuance. In the city of New York, particularly, not only the Board of Trade and Transportation, but the "Produce Exchange," a body numbering in its membership nearly 3,000 of the produce commission and other business men of that city, have addressed Congress in urgent appeals in behalf of the canal in question, usually denominated the "Hennepin Canal." In May, 1881, there assembled at Davenport, Iowa, a delegate body of about four hundred members, representing commercial bodies, municipal corporations, and farmers' associations of seven different States, expressly to urge upon the attention of the country the desirability of, and necessity for, the construction of the said canal by the General Government. That convention, attended and addressed by governors of States, members of Congress, and prominent business men, emphatically urged upon Congress the great importance of the proposed canal as a means to secure to the people a greatly needed improvement of facilities for the transportation of their products and commodities.

The reasons which have been and are presented in support of this action and these appeals may be thus summarized:

1. Cheap transportation to the East is even more an absolute necessity to the Upper Mississippi Valley than is such transportation to the South. In the direction of securing the latter very much has been done during the past fifteen years. The improvement of the Rock Island and the Des Moines Rapids, the removal or the reduction of numerous sand-bars, &c., and the construction of the jetties at the mouth of the river have each been of great advantage to those whose products seek a Southern market, or can be transported to Europe by way of New Orleans. But it is urged that, after all, the main arteries of commerce flow from the West to the East and from the East to the West. Several co-operative causes are responsible for this:

- a. The greater shipping ports of European markets are on the Eastern Atlantic seaboard, for to these are made the larger number of imports, so that the vessel leaving thence laden with cereals and provisions from the West can offer to these cheaper freightage, because sure of return cargoes at rates which are the most remunerative as a result of the shorter ocean voyage, as compared with that required from ports more distant from Liverpool, or London, or Bremen.

- b. In the East are the manufacturing centers and the populous cities, the necessities of which make constant demand for the grains and breadstuffs, the meats, and the dairy products of the Northwest. From the East, also, the Northwest most largely draws its supplies of manufactured articles, machinery, staple goods, &c.

- c. In the East are the strong competitors for the products of the Northwest, the markets at Baltimore, Philadelphia, New York, Boston, Portland, Montreal, and Quebec, which are not only connected with the Northwest by the great trunk railroad lines which stretch from Chicago to the ocean, but which enjoy also more or less directly the free use of the lakes, the Erie or the Welland Canal, the Hudson, or the Saint Lawrence.

These and other notable facts press upon attention the truth that if the Upper Mississippi Valley is to at all attain the development so unmistakably promised in the wealth of its resources and the energies of its people, it must have opportunities for transportation of its products and commodities which shall be equally direct and inexpensive eastward or southward.

2. It is the particular misfortune of the Upper Mississippi Valley that it has no share in the vast benefits which accrue to the lake region in the matter of competition and cheap transportation, secured through the use of a water route which has its westward terminus at Chicago and its eastern in New York Harbor. The potency of the competition in freight charges maintained by the water route of the lakes, the Erie Canal, and the Hudson stands confessed. Yet the striking facts pertaining

thereto are worthy of special reference here. Thus, in a letter to the Hon. William Windom, United States Senator for Minnesota, Mr. Albert Fink, the well-known railroad commissioner, wrote in 1878: " * * * You are aware that when the rates are reduced between Chicago and New York on account of the opening of the canal, this reduction applies not only to Chicago, but to all interior cities (Saint Louis, Indianapolis, Cincinnati) to New York. If that was not the rule, the result would be that the roads running, say from Saint Louis, Indianapolis, and Cincinnati to Chicago, would carry the freight to Chicago, from which point low rates would take it to the East, and leave the direct road from the interior points to the seaboard without any business. Hence, whenever the rates are reduced on account of the opening of navigation from Chicago and lake ports, the same reduction is made to all interior cities, not only to New York, where the canal runs, but to Philadelphia and Baltimore. Although the latter cities have no direct water-route communication with the West, yet they receive the benefit, as far as railroad rates are concerned, the same as if a canal were running from the lakes direct to these cities, because whenever rates from Chicago to New York are reduced it is necessary to reduce the rate from Chicago to Boston, Philadelphia, and Baltimore; otherwise the business would all go to New York. The reduction of the rates from Chicago and Saint Louis to Baltimore causes a reduction in rates on shipment via Baltimore to Atlantic ports—Norfolk, Wilmington, Port Royal, Savannah, Brunswick, and Ferdinandina—and from there into the interior Atlantic Gulf States—Augusta, Atlanta, Macon, Montgomery, Selma, &c. * * * These roads * * * are obliged to follow the reduction made via the Baltimore road, and which were primarily made on account of the existence of the Erie Canal and the opening of navigation. The same way in regard to the west-bound business, * * * so that it may be said that the rail rates are kept in check by water transportation."

Were it necessary so to do, such citations of eminent authority as is thus quoted might be multiplied indefinitely. But, while this potential influence of the water-route competition of the lakes and of the Erie Canal is widely felt at Chicago and all over the country eastward and southward from Chicago, its westward trend practically ends at Chicago. It so ends at Chicago, so far as the Upper Mississippi Valley is concerned, because there is no water route open to the Upper Mississippi by which Chicago and the lakes can be reached. It is to meet that difficulty that the Hennepin Canal is necessary. In a word, the construction of the Hennepin Canal and the use of the Illinois and Michigan Canal will extend to the Upper Mississippi River the water-route competition in freight charges now terminating westward at Chicago.

3. The great gain to the entire region west of Chicago to result from the extension to the water-route competition and cheapness to which attention has been directed may be approximately estimated on comparison of railroad freight charges on lines of commerce with which water routes of transportation come into competition and those on which no such competition is known.

The reports of the leading trunk lines, collated by Mr. Joseph Nimmo, jr., in a table illustrating the successive reduction of freight charges on those roads and on the Erie Canal, respectively, furnish striking evidence on this point. (Internal commerce of the United States for 1880, Appendix, page 230.)

Of twelve of the railroads therein enumerated, maintaining an average freight charge of from 1.85 to 3.168 cents per ton per mile, respectively, in 1868, the only ones maintaining for the year 1880 an average freight charge of .88 of a cent, per ton per mile were those having no water-route competition. This is a summary of that exhibit as to the charges for 1880 per ton per mile:

RAILROADS HAVING COMPETITION IN WATER ROUTES.

	Per ton per mile.
New York Central Railroad.....	\$0 00.88
Pennsylvania Railroad.....	00.88
New York, Erie and Western Railroad.....	00.84
Philadelphia and Erie Railroad.....	00.56
Lake Shore and Michigan Southern Railroad.....	00.75
Michigan Central Railroad.....	00.842
Pittsburgh and Fort Wayne Railroad (for 1879, for 1880 not given).....	00.76

RAILROADS NOT COMPELLED TO MEET WATER-ROUTE COMPETITION.

	Per ton per mile.
Boston and Albany Railroad.....	\$0 01.20
Chicago, Burlington and Quincy Railroad (for 1879, for 1880 not given)...	01.023
Chicago and Northwestern Railroad (for 1879, for 1880 not given).....	01.49
Chicago, Milwaukee and Saint Paul Railroad (for 1879, for 1880 not given)...	01.76
Chicago, Rock Island and Pacific Railroad (for 1879, for 1880 not given)...	01.21
Erie Canal rate for 1880.....	\$0 00.49

Thus it will be seen that the four leading trunk railroads running to Chicago from the Upper Mississippi Valley States maintained an average of .63 of a cent per ton per mile freight charge in excess of the average freight charge of seven other trunk railroads eastward of Chicago, where tariff rates were, as Mr. Fink has explained, constantly under the control of the potentially operative competition of the water routes of the lakes and the Erie Canal. The fact thus cited to attention is a very important one. Its existence is urged as furnishing an argument for the opening up of an extension of the water route of the lakes to the Upper Mississippi so strong that its force can neither be moderated nor escaped. Assessed upon the entire cereal products of the States from which that extra freight charge is collected, the annual aggregate would alone reach the sum of \$3,482,687, if only the crop yield of the principal cereals of Iowa, Minnesota, Kansas, Nebraska, and one-half of that of Illinois and Wisconsin be taken into the account, estimating these products at 2,785,350 tons weight and the increased cost at \$1.25 per ton, average.

But that added freight charge, thus resulting from the absence of water-route competition from the Upper Mississippi to the lakes at Chicago, is not alone collected on the cereal products of the States enumerated. It is none the less chargeable upon and collected on the reported cattle and hogs, the cured and barreled meats, and the dairy products and the imported articles of those several States. A just computation of those charges would give a total of annual loss to the people which would be deemed altogether fabulous and impossible by those who have not given attention to the facts actually involved.

These facts find earnest enforcement, moreover, in yet others directly illustrating the beneficent results to producers and consumers attendant upon the maintenance of water-route competition with railroads. For example, the freight charges by rail during the past season on wheat from Saint Paul to Chicago or Milwaukee were 20 cents per 100 pounds in car-load lots, or 12 cents per bushel. From Saint Paul to Davenport or Rock Island, by the Mississippi River, the charges were 3 cents to 4 cents per bushel for wheat, although lower rates were frequently accepted. From La Salle, on the Illinois River, and the northern terminus of the Illinois and Michigan Canal, as also from Henry, 30 miles south of La Salle, the charges of last season on wheat were 3 cents per bushel, including State tolls on canal. Deducting the State tolls, $1\frac{1}{2}$ mills per 1,000 pounds per mile, and 3 cents per mile on boats, or 7 mills per bushel of wheat, the actual charge for transportation would have been 2.3 cents per bushel.

Now, estimating the cost of transportation on the proposed Hennepin Canal from at or near Rock Island to the Illinois River, at or near Hennepin, say 63 miles, at the same rate per bushel per mile charged on the 100 miles of the Illinois and Michigan Canal free of tolls, at $1\frac{1}{2}$ cents per bushel of wheat, then by an all-water route from the Upper Mississippi to the Illinois River and thence to Chicago, the freight from Rock Island to Chicago would be 3.8 cents per bushel. But this estimate, it is to be noted, is based upon the present use of canal-boats of only 160 tons on the Illinois and Michigan Canal. The proposed Hennepin Canal, however, contemplates use of boats of 260 tons; and an enlargement of the Illinois and Michigan Canal to an equal accommodation of tonnage would secure a reduction in freight charges of fully 25 per cent. on the 100 miles from La Salle to Chicago. This would lessen the charge to an extent of nine-tenths cent per bushel. The actual charge per bushel from Saint Paul to Chicago, *via* the Mississippi River, the Hennepin Canal, would then be as follows:

	Cents.
Saint Paul to western terminus of Hennepin Canal.....	3
Mississippi River to Chicago, <i>via</i> Hennepin and Illinois and Michigan Canals.	2.9 or 3
Total from Saint Paul to Chicago.....	6

Thus there would be effected a saving of six cents per bushel on wheat from the Upper Mississippi River districts to Chicago, and so, on the vast aggregate of that cereal now compelled to seek entrance upon the water route of the lakes only through transportation by railroad.

Actual results are shown already, it may be further urged, as due to the direct competition of canal and railroad, in the case of Illinois and Michigan Canal and the railroads by which it is paralleled. The railroad commissioners of Illinois established the freight charge on wheat by rail last season at 11 cents per 100 pounds, or 6.6 cents per bushel, for 100 miles, the distance from La Salle to Chicago; for 130 miles, the distance from Henry, on the Illinois River, to Chicago, 12 cents per 100 pounds, or 7.2 cents per bushel; for 182 miles, the distance from Rock Island to Chicago, 13.4 cents per 100 pounds, or 8.2 cents per bushel. It has been freely stated and generally believed that the railroads have regarded these rates of the commissioners as too low. Yet wheat was last season taken from Henry and from Peoria, each on the Illinois River, for 3 cents per bushel, by rail while the schedule rates were 7.2 cents per bushel. Thus were the rates of the railroad compelled to fall to a point of equality with those of the

canal; while on lines not so placed in competition with [that water route the rates from shipping stations of equal distance from Chicago with those of Peoria, Henry, and La Salle were required to pay the full schedule rate as established by the commissioners.

These illustrations give emphasis to, but do not at all exhaust, the facts which are relied upon to support to the utmost this the third reason thus urged by which the desire for the construction of the Hennepin Canal is enforced.

4. The vast volume attained by the annual cereal product of the States directly tributary to the Upper Mississippi presents yet additional support to the plea for an all-water transportation route to the East. The annual report of the Chicago Board of Trade for 1882 estimates the crop yield thus:

Illinois:		Bushels.
Wheat.....	52,302,900	
Corn.....	187,336,900	
Oats.....	18,696,000	
Total.....	258,335,800	
Iowa:		
Wheat.....	25,487,200	
Corn.....	178,487,600	
Oats.....	99,141,000	
Total.....	303,115,800	
Kansas:		
Wheat.....	33,248,000	
Corn.....	150,452,600	
Oats.....	29,700,000	
Total.....	213,400,600	
Nebraska:		
Wheat.....	14,947,200	
Corn.....	82,478,200	
Oats.....	44,555,700	
Total.....	141,981,100	
Minnesota:		
Wheat.....	37,030,500	
Corn.....	21,127,600	
Oats.....	9,417,650	
Total.....	67,575,750	
Wisconsin:		
Wheat.....	20,145,400	
Corn.....	30,201,600	
Oats.....	12,780,800	
Total.....	63,127,800	

Thus is presented a grand total of 1,047,536,850 bushels as the product of three cereals only, in a single year from six States, constituting only a part of the widely extended area certain to be affected and benefited by an extension to the Upper Mississippi of the water-route system of transportation reaching westward from New York, but now having its westward terminus at Chicago. But consideration of these facts would be seriously incomplete were it not made to include the fact that, vast as are the aggregates of productions in the States named for the year 1882, they are certain

to be yet largely increased year by year. Comparative statistics are almost startling in that regard; thus, as a single illustration where many might be given, the wheat product of Iowa from 1849 to 1860, as shown by carefully compiled statistics, aggregated 50,000,000; from 1860 to 1870, 195,000,000; from 1870 to 1881, 375,000,000 bushels. Of corn the yield was, from 1849 to 1860, 250,000,000; from 1860 to 1870, 550,000,000; and from 1870 to 1881, 1,800,000,000 bushels. Estimating the wheat at 85 cents per bushel and the corn at 35 cents, a curious statistician has recently shown (see Clinton Iowa Agriculturist, February 2, 1883) that the total value of these two crops in Iowa, excluding those of 1882, would equal \$1,177,000,000, or more than the highest estimate of the value of all the gold product of California from its discovery on June 19, 1848, to June 30, 1881.

In this connection, too, may be cited the fact that while the total wheat crop of the United States increased from 181,199,000 bushels in 1867 to 498,549,000 bushels in 1881, the larger part of that increase was signalized in the States of the Upper Mississippi Valley.

This astonishing development in the great growth of a single cereal, however, does but faintly indicate the wondrously rapid advance of these States in relation to other productions; for corn, cattle, hogs, butter, cheese, fruits, &c., are, it is notorious, largely enlisting effort for their increase on the part of the farmers of the Northwest, and that with great success.

5. The fact that the producers of the Northwest do and must increasingly look to the exportation of their cereals, provisions, dairy products, and cattle, as offering the surest market and the largest profit, has also great weight in the argument urged in behalf of the Hennepin Canal. Those European markets are no longer left to supply by American producers. These are invited, but only in competition with those of other countries. The freight rates to be paid in transporting products from the Upper Mississippi to Liverpool often alone determine the possibility or impossibility of profitable exportation. On this point the evidence taken in New York by a committee of the State senate appointed to investigate the facts as to the relative advantages to commerce of the Erie Canal was conclusive. That committee, which had its sessions in September, 1881, recorded the testimony of prominent members of the New York Produce Exchange, which asserted that it frequently happened that the difference of one cent per bushel in the price of wheat in New York City determined the ability or inability of the commission men and dealers to make shipments to European markets. One shipper placed that controlling difference as low as one-fourth of a cent per bushel. It was also the concurrent statement of several of the gentlemen testifying that advance in freight rates frequently estopped grain exportations, while freight reductions stimulated such movements of cereals, and gave legitimate impetus to the grain markets of the entire country (see printed report of New York senate committee on Erie Canal, submitted to general assembly of 1882).

So manifestly correct are these several testimonies that they were even anticipated by Mr. Joseph Nimmo, jr., of the Bureau of Statistics, when he said in his report on the commerce of the United States for 1880 (page 154):

"The price of all commodities of low value in proportion to weight is in every market greatly affected by the cost of transportation.

"Especially is this the case in regard to the surplus agricultural products of the Western and Northwestern States. The low rates which prevail for transportation upon the Northern water lines, therefore, exercises an important regulating influence over the price of all the products of the West, not only in the markets of the Atlantic seaboard States, but also in foreign countries; it is due chiefly to this fact during the last ten years that the value of domestic exports from the United States has greatly increased, and that since the year ended June 30, 1875, the value of exports from the United States has largely exceeded the value of imports to the United States."

Testimony and statement in this direction could here be indefinitely cited in addition, from official and unofficial authorities, did the limits assigned to this paper permit. It must suffice, however, to suggest thus the mere outlines of fact and argument co-operating in urgent appeal for the construction of a canal the needs for which are really national, and the directly beneficent influence of which, were it completed and in operation, would be realized from the Missouri to the Hudson.

6. Scarcely less important to the Upper Mississippi Valley region than the report of its products, rendered possible and profitable only when cheap transportation is secured, is the ready and inexpensive delivery of its imports. The aggregate of these increases year by year, while it has already reached proportion and value which are literally immense. Thus, not only are vast totals of anthracite coal and crude and manufactured iron from Pennsylvania, pottery from New Jersey and Ohio, hard woods from Indiana, and stone and bituminous coal from Eastern Illinois shipped in large quantities to the Upper Mississippi Valley States, but the cotton goods of Massachusetts, the woollens of Rhode Island, the machinery of Connecticut, the agricultural implements of New York, all constituting heavy bulk freights, are constantly add-

ing to the number of their consumers in the wide area of territory to be more immediately benefited by the construction of the Hennepin Canal.

A single locality may here be specifically mentioned as furnishing significant illustration of the general fact thus urged to attention. The tri-cities of Moline, Davenport, and Rock Island (to name each in the order of its manufacturing importance) have had their respective business interests carefully revised, in statistical form, at the close of each year, for the columns of the Davenport Gazette. The last of these reports, that of January 1, 1883, for the year 1882, presents some noteworthy figures: A single plow manufactory establishment at Moline (Deere & Co.) consumed in 1882 1,110 tons of steel, 3,000 tons of wrought iron, 900 tons of pig iron, 300 tons of malleable iron, 2,000,000 feet of oak and ash lumber, 400 tons of grindstones, 30 tons of emery, and 250 barrels of oil and varnish, employing weekly 700 men. Another establishment (The Moline Company's plow works) used only a less aggregate of similar material, the value of the product of these two establishments footing up to \$2,500,000 for the year. The Moline Wagon Company manufactured goods to the value of \$625,000, the Deere Planter Company to the value of \$600,000, the two malleable-iron companies to the value of \$280,000, the machine, engine, and boiler shops to the value of \$480,000, the paper mills to the value of \$150,000, the pump factory to the value of \$125,000, while the saw-mills and other establishments aggregated a yield of products exceeding in value a million dollars more. In Davenport the enumerated manufactures of the year—agricultural implements, lumber, flour, oatmeal, glucose, carriages, woolen goods, cigars, clothing, &c.—aggregated a value of \$5,864,876, and the value by jobbing houses, the sum of \$8,046,730; the shipments of local freight by three railroads, 17,536 car-loads, and the receipts, 16,653 car-loads. In Rock Island the plow works manufactured goods in excess of a million dollars in value; the glass works to the value of \$200,000, stove works to value of \$100,000, the saw-mills, 80,031,866 feet of lumber only, and 18,328,750 shingles, 16,653,000 lath, and 198,650 pickets. If to this partial exhibit of the manufacturing interest of Rock Island City were added those of the United States Arsenal on Rock Island the aggregate of railroad shipments would be 17,982 car loads shipped, and 18,258 forwarded by four roads, including the receipts and exports of coal, largely mined from the extensive coal fields lying within an area of 15 miles east and northeast of Rock Island.

It is important to note in this connection that even the wholesale dry goods houses of such Upper Mississippi cities as Keokuk and Dubuque also, as indeed those of the entire region west of Chicago are accustomed to, direct that shipments to them of baled goods, sheetings, muslins, calicoes, &c., of which they purchase largely in early summer, shall be sent to Chicago from New York wholly by water-route transportation. It is the constant experience of these business men that their freight charges from Chicago west to their respective cities equal from one-half to two-thirds of the entirety of such charges from New York to Chicago. Indeed, it is in proof that for distances of only 200 miles from Chicago and less the freight charges have in many instances exceeded those made from New York to Chicago. As a result, it can be conclusively established that the extension to the Upper Mississippi of the water-route transportation enjoyed from New York to Chicago would considerably enhance the legitimate profits of all dealers in staple manufactured goods, while largely reducing the cost of these to consumers.

In illustration of the undeniable fact thus cited to attention it may be stated that anthracite coal transported from the Lackawanna mines in Pennsylvania to Chicago at a net freight charge of \$1.40 per ton has continuously cost \$2 per ton additional as its freight charge to the Upper Mississippi River from Chicago. When it is remembered that the use of this Pennsylvania coal throughout the entire Northwest, even to Denver, Colo., is constantly increasing year by year, it will be seen that the certain reduction of freight charges from Chicago to the Upper Mississippi, to the extent of at least one dollar per ton, to follow the construction of the Hennepin Canal, would constitute a great boon to hundreds of distant communities and to many thousands of people scattered over a widely extended area of country. Similarly, also, a large aggregate of Northwestern citizenship would be greatly benefited by the reduction in the cost of bituminous coal taken from the Illinois River coal fields, sure to result, in all the Upper Mississippi River cities and towns, and the communities having ready communication therewith, from the transfer of loaded coal barges from the former river to the latter river by way of the proposed canal. Such barges could readily be towed from the western outlet of that canal direct to Saint Paul and Minneapolis, so as to place the Illinois River coal in those cities at a cost of at least one dollar a ton less than that now paid therein. Such is the demonstrable fact of unquestionable computation of all expenses to be incurred in such a transfer of coal products from the miners to the consumers.

7. It is essential to a correct understanding of the demand for the construction of the proposed canal that the fact be fully comprehended that Chicago is the natural and the inevitable center of the commerce of the entire Northwest. In that city is found not only the best market for all the products of the Upper Mississippi Valley region,

but the market for such products. There is really purchased, as the reports of Mr. Charles Randolph, secretary of the Chicago Board of Trade, conclusively show, eight-tenths of all the grain and provisions moved eastward for export to Europe.

To reach that central market readily, directly, and cheaply is, therefore, a prime concern of the producing classes of the Upper Mississippi Valley.

8. During the past few years there has resulted a radical change in the methods of transporting cereals. Grain is no longer sacked for shipment. Instead it is carried in bulk from the various points in Minnesota, Wisconsin, and Iowa, on the Upper Mississippi; the grain is loaded into barges in bulk and is in them floated down to railroad elevators at such other points as La Cross, Dunleith, and Savannah, there to be transferred to railroad cars and carried to Chicago, or moved further down the river to Saint Louis, there to be transferred to larger barges and in these carried to New Orleans. In the instance of one contract executed in the summer of 1881 a large quantity of wheat was thus taken from Saint Paul to New Orleans without breaking of cargoes, but such a transit can be made only during seasons of high water on the Upper Mississippi, since the grain barges used on the river below Saint Louis draw 6 to 7 feet water, while the depth of the Upper Mississippi channel admits passage of barges drawing 4 feet only, in ordinary stages of navigation. Therefore, during by far the greater part of each season it is impracticable to carry grain in barges from Upper Mississippi River points to New Orleans without breaking bulk; just as it is impracticable to carry such cargoes to Chicago without similar breakage of bulk. What is needed, then, is that grain-laden barges shall be enabled to float from any Mississippi River point direct to Chicago just as originally placed in cargo. This is what the canal under consideration will permit and render certain, reliable, and inexpensive. Such barges loaded with grain in bulk will, after reaching Chicago by way of the Mississippi River, the Hennepin Canal, the Illinois River, and Michigan Canal, return to their starting points bearing cargoes of iron, coal, machinery, agricultural implements, heavy case goods, crockery crates, &c., leaving freight charges largely less than can possibly be obtained where railroads are alone the transportation agents.

9. It is not pretended by any intelligent advocate of the proposed canal that it will, or can, compete with railroads in the transportation of light freights or perishable goods. It is not, therefore, "opposition to railroads" which inspires the movement for the canal which has during the past few years increasingly enlisted the sympathy and support of the people of Illinois, Iowa, Minnesota, and Wisconsin with more or less earnestness. On the contrary, there are not wanting very sagacious friends of existing railroads, and zealous advocates of the projection and completion of still other and new railroads, who are clear in the conviction that the extension to the Upper Mississippi of the water-route transportation system of the Erie Canal and the Lakes will so greatly enhance the prosperity of the Northwest, will so develop the country immediately tributary to such extended water-route, and will so increase the lighter freight traffic and passenger travel of the railroads occupying territory contiguous to the route of the canal under consideration, that the railroad interests will be really benefited by the construction of the canal rather than otherwise. In support of this view it is insisted that the actual saving in annual freight charges on cereals, provisions, and other heavy products, together with similar savings quite as certain to result on the cost of transportation on bulky and weighty commodities to be purchased by the people raising such products, will so greatly increase their ability to expend money in other directions, that the receipts of the railroads will find increase rather than reduction, as a result of the water-route extension under consideration. The aggregate of such savings annually would unquestionably be very large. The amount can only be approximately estimated. A moderate competition on the actual shipment of the grain alone raised in the States of Iowa, Kansas, Nebraska, Minnesota, the western half of Missouri, and the western half of Wisconsin must place that annual raising to the producer, in the matter of freight charges, solely at much more than \$3,000,000. Such an estimate will be much below the actual sum total rather than at all in excess thereof. If, then, to that sum is added a just estimate of the saving certain to result on the freight charges on commodities imported into the States named, which freights are relatively much higher on such importations than on the cereal exports, it will be seen, it is insisted, that the saving to the people of the Upper Mississippi River States to be effected as a result of the building and operation of the Hennepin Canal cannot be less annually than \$5,000,000. These are the additions to the wealth of the people in which the railroads used by the people benefited would so certainly share.

10. So rapidly are increasing the yearly products of the Northwest that, as is well known to shippers and business men generally, it has already become a serious question, during the periods in which grain and stock are being pressed forward to a market, whether the limits of capacity in railroad freight transportation have not been nearly reached. Were it necessary so to do, a series of statistical facts could here be given, as quoted from official sources, showing a constant increase of productions in the Northwest which is really marvelous and which unmistakably indicates the necessity, no less than the wisdom, of more generous efforts to extend and increase the

facilities afforded for the transportation of those products to the chief market they so inevitably and pressingly seek—the markets of Chicago and the Eastern Atlantic ports.

11. A single point only remains to be noticed. This is that the railroads cannot possibly carry bulky and heavy freights as cheaply as these can be transported on canal, river, and lake. This is as true as to the railroads which have been made the receipts of generous aid from the General Government, through grants of public lands, which in themselves would to-day constitute a princely domain, as it is of roads built wholly through the investment of private and corporate moneys. This is shown in the fact that while the freight charges on the Erie Canal were successively reduced from .872 per ton per mile in 1868 to .49 cent per ton per mile in 1880, as already shown herein (including tolls to the State), the land-grant roads of the Northwest maintain their routes at an excess of 1.20 cents per ton per mile. Later reports of these roads than those hereinafter cited show only slight reduction, and so furnish even additional proof of this. For instance, for 1882 the average freight charge of the Illinois Central was 1.41 cents per ton per mile; that of the Chicago and Alton 1.031 cents; that of the Chicago, Burlington, and Quincy 1.19 cents; the Chicago and Rock Island and Pacific 1.22 cents; the Chicago and Northwestern 1.465 cents; and the Chicago, Milwaukee and Saint Paul 1.77 cents per ton per mile.

This last consideration gives emphasis to the argument, it is urged, which presses upon the General Government the duty of securing to the people that cheap transportation which is possible only in the use of the natural water-ways of the country and of such connections of these with one another as can be readily made, at a relatively small expense, and which will, when made, open up to wide areas of territory established water-routes to which they are now practically denied access.

These are some of the considerations which are pressed in support of the request for the construction of the proposed Hennepin Canal. It is urged with much earnestness, by citizens of careful thought and extended business observation and experience, that these and other considerations not herein enumerated justly entitle the canal in question to approval and support as a national enterprise of great merit and increasing importance.

AN ACT ceding the Illinois and Michigan Canal to the United States.

SECTION 1. *Be it enacted by the people of the State of Illinois, represented in the General Assembly,* That the Illinois and Michigan Canal, its right of way and all its appurtenances, and all right, title, and interest which the State may now have in any real estate ceded to the State by the United States for canal purposes, be, and are hereby, ceded to the United States for the purpose of making and maintaining an enlarged canal and water-way from Lake Michigan to the Illinois and Mississippi rivers; and this cession is made upon the condition that the United States shall, within five years from the time this act takes effect, accept this grant, and thereafter maintain the said canal and water-way for the purpose aforesaid. In case the United States shall accept this grant, it is upon the express condition that the canal shall be enlarged in such manner as Congress may determine, and be maintained as a national water-way for commercial purposes, to be used by all persons, without discrimination, under such rules and regulations as Congress may prescribe; and the real estate aforesaid, hereby conveyed to the United States, shall be used, and the avails thereof applied, to carry out the objects of this grant, and for no other purpose, in such manner as Congress may determine.

SEC. 2 The general assembly shall have power to withdraw and revoke this proposed grant at any time previous to its acceptance by Congress, but when the United States, by act of Congress, shall accept the grant and conditions provided for by section one of this act, the governor shall immediately thereafter execute and deliver in the name of the State of Illinois, to the United States, a deed of cession in accordance with the provisions of this act, and shall then and there, or as soon as practicable, surrender all property mentioned in this act, to be granted to the proper authorities of the United States; and until the delivery of such deed, and acceptance of the same (together with the property conveyed) by the United States, the authority and duty of the State of Illinois to operate said canal, and control its property and appurtenances, shall in no respect be impaired.

SEC. 3. This act shall not take effect until it shall first have been submitted to a vote of the people of the State of Illinois at the general election to be held on Tuesday, the fifth day of November, A. D. 1882, and have been approved by a majority of all the votes polled at such election. At the said election the ballots, in so far as they relate to this act, shall be in the following form: "For the act ceding the Illinois and Michigan Canal to the United States;" and when so voted, it shall count in favor of

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this act, but if canceled with ink or pencil, it shall be counted against this act. The returns of the whole vote cast at said election, and of the votes for the adoption or rejection of this act, shall be made and canvassed by the same officers and in the same manner as are the returns of the votes for senators and representatives of the State of Illinois; and if it shall appear that a majority of the votes polled are "for the act ceding the Illinois and Michigan Canal to the United States," the governor shall make proclamation thereof, and this act shall take effect from and after the date of such proclamation; but if a majority of the votes cast are "against the act ceding the Illinois and Michigan Canal to the United States," then this act shall be null and void.

Approved April 28, 1882.

ESTIMATES.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., February 23, 1883.

GENERAL: I have the honor to transmit herewith, in advance of the report, the estimates for the construction and maintenance of the Hennepin Canal, and the enlargement of the Illinois and Michigan Canal, as provided for in the act of Congress passed August 2, last.

Three lines for the canal, from Hennepin to the Mississippi, with a feeder from Rock River, at Dixon, were surveyed, and are designated below as the routes to Marais d'Osier, Watertown, and Rock Island.

It is proposed to make the canal and feeder 80 feet wide on the water line and 7 feet deep, with locks 170 feet long and 30 feet wide. The same dimensions are taken for the Illinois and Michigan Canal.

MARAIS D'OSIER ROUTE.

Length, 64 miles.	
Number of locks, 31.	
Estimated cost of construction of canal and feeder, including right of way	\$5,811,367 50
Estimated cost of maintenance and ordinary repairs, annually	88,600 00
Dredges	36,000 00

WATERTOWN ROUTE.

Length, 65 miles.	
Number of locks, 32.	
Estimated cost of construction of canal and feeder, including right of way	\$7,207,646 88
Estimated cost of maintenance and ordinary repairs, annually	91,245 00
Dredges	36,000 00

ROCK ISLAND ROUTE.

Length, 75 miles.	
Number of locks, 35.	
Estimated cost of construction of canal and feeder, including right of way	\$6,672,890 67
Estimated cost of maintenance and ordinary repairs, annually	94,820 00
Dredges	36,000 00
The length of the feeder from Rock River at Dixon is 37 miles, and its estimated cost included in the above is	1,664,117 52

ENLARGEMENT OF THE ILLINOIS AND MICHIGAN CANAL.

Length, 96 miles.	
Number of locks, 16.	
Estimated cost of construction	\$2,298,919 15
Estimated cost of maintenance and ordinary repairs, annually	50,000 00

It is impossible to estimate for extraordinary repairs, renewals, &c.; these will have to be provided for, from time to time, by the necessary appropriations for that purpose.

There are transmitted herewith sheets giving in detail the estimated cost of the different lines and the feeder. In explanation thereof, it will be noted that the Marais d'Osier line leaves the Watertown route at the twenty-fifth mile, and the Rock Island line leaves it at the fifty-seventh.

Very respectfully, your obedient servant,

W. H. BENYAURD,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

Estimate for the cost of construction of the Hennepin Canal.
MAIN LINE VIA THE MARAIS D'OSIER.

Miles from Illinois River.	Earthwork.			Lift-locks.		Cost of culverts.	Bridges.		Cost of concrete lining, at \$4 per cubic yard.	Cost of right of way, and special damages.	Cost of fencing, at \$1 per rod.	Special work.		Amounts.
	Cubic yards.	Price per yard.	Cost.	No. of lock.	Lift.		Highway, cost.	Railroad, cost.				Kind.	Cost.	
1	158,858.1	\$0 15	\$23,828 70							\$440 00	\$540 00	Basin Illinois River.	\$9,881 40	\$34,790 10
2	89,183.7	20	17,836 75	1 1 2 2	9	\$86,955 50	\$1,200 00	\$4,258 70		660 00	640 00			118,350 20
3	63,527.1	20	12,705 40		9	43,477 75		7,720 84		2,660 00	480 00	Retaining wall.	2,199 85	43,477 75
4	105,728.1	20	21,145 60		8	42,727 75						Riprap.	2,980 00	40,938 24
5	65,997.8	20	13,199 55		9	43,477 75	4,325 00			880 00	320 00	do.	1,172 00	2,980 00
6	83,457.2	20	16,691 45		6	42,727 75	3,182 80			1,100 00	320 00	do.		139,103 14
7	90,451.7	20	18,090 35		9	43,477 75	4,325 00			980 00	320 00	Riprap.	1,172 00	62,422 30
8	64,182.8	20	12,836 55		8	2,329 80	8,345 00			980 00	320 00	do.	2,980 00	74,890 00
9	50,942.4	20	11,988 50		9	88,068 00				880 00	320 00	do.		139,276 00
10	48,281.0	20	9,672 20		10	8,097 26				1,960 00	640 00	do.	8,790 00	89,128 85
11	77,650.3	20	15,530 05		9	3,483 85				3,220 00	640 00	Excavation for race.	432 25	143,124 41
12	82,390.3	20	16,478 05		10	6,061 95	1,887 50			2,880 00	640 00	Riprap.	5,800 00	17,588 30
13	104,053.1	20	20,810 60		12	88,068 00	1,719 50			1,980 00	320 00	do.	2,980 00	87,375 25
14	88,965.8	20	17,793 15		9	96,205 50	5,983 00			1,980 00	640 00	do.	2,980 00	192,206 20
15	229,610.2	20	45,922 05		10	89,160 50				3,880 00	640 00	do.		131,375 76
16	164,470.4	20	32,894 10		17	44,580 25				2,980 00	640 00	do.	2,980 00	119,943 66
17	92,761.0	20	18,550 20		7	85,990 50	11,580 00			5,320 00	320 00	do.	2,980 00	99,109 80
18	89,157.0	20	17,831 40		21	85,990 50				8,320 00	640 00	Arch under C. H. and Q.	16,083 35	281,294 05
19	84,176.0	20	16,835 80		9	43,477 75	4,108 50			3,320 00	640 00	Riprap.	1,172 00	182,870 08
20	128,904.0	20	25,780 80		9	43,477 75	9,804 50			4,060 00	640 00	do.		1,172 00
21	98,704.0	15	14,805 60							5,540 00	640 00	do.		75,834 07
										860 00	640 00	do.		84,307 65
										220 00	640 00	do.		97,740 78
												do.		14,544 90

26,542 35	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 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00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00	640 00	2,200 00
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Estimate for the cost of construction of the Hennepin Canal—Continued.

MAIN LINE TO WATERTOWN.

Miles from Illinois River.	Earthwork.		Lift-locks.		Cost of culverts.	Cost of weirs.	Bridges.		Cost of concrete lining, at \$6 per cubic yard.	Cost of right of way, and special damages.	Cost of fencing, at \$1 per rod.	Special work.		Amounts.
	Cubic yards.	Price per yard.	No. of locks.	Cost.			Highway, cost.	Railroad, cost.				Kind.	Cost.	
25	66,748.0	20	15	\$470,301.15										\$64,303.13
26	73,356.0	20	24	13,249.60	\$1,001,320.75	\$107,289.73	\$83,360.25	\$11,979.54	\$110,880.00	\$54,090.00	\$13,600.00			\$238,971.94
27	73,356.0	20	10	44,580.25	13,415.55	8,943.70	5,700.00			1,600.00	640.00			78,465.40
28	73,356.0	20	14	6,433.80						2,320.00	640.00			25,914.90
29	66,409.0	20	20	18,281.80			4,200.00			380.00	640.00			21,863.90
30	51,748.0	15	10	44,580.25		2,143.50	1,500.00			228.00	640.00			63,025.55
31	52,928.0	15	7	7,939.20		17,887.40				1,440.00	640.00			26,569.60
32	53,497.0	15	8	8,024.55		4,943.30				1,600.00	640.00			10,019.20
33	71,495.0	15	10	724.25		13,415.55				1,600.00	640.00			14,287.88
34	80,789.0	20	16	147.80		1,655.50	4,200.00			1,880.00	640.00			26,439.80
35	83,442.0	20	16	688.40		3,410.30				1,880.00	640.00			24,132.30
36	61,514.0	20	13	302.80		3,410.30				1,600.00	640.00			63,088.20
37	93,662.0	20	26	18,732.40		3,410.30	5,700.00				640.00			37,017.60
38	100,718.0	20	20	143.60						880.00	640.00			119,335.95
39	57,090.0	20	30	11,418.00			4,200.00			2,100.00	640.00			22,863.60
40	45,512.0	20	9	102.40		1,655.50	4,200.00			1,160.00	640.00			16,098.00
41	55,943.0	20	11	188.60		4,046.00	4,200.00			1,860.00	640.00			16,757.90
42	55,151.0	20	11	680.20						1,860.00	640.00			20,954.60
43	83,623.0	20	16	725.00		1,655.50	8,100.00			2,820.00	640.00			18,550.20
44	42,904.0	20	8	580.80		4,046.00	4,200.00			2,820.00	640.00			24,300.50
45	72,944.0	20	14	588.80		8,277.00	4,200.00			1,860.00	640.00			43,868.80
46	110,698.0	20	23	117.20		4,046.00	4,200.00			1,860.00	640.00			26,794.80
47	91,709.0	20	8	42,727.75		2,143.50	4,200.00			1,860.00	640.00			37,508.30
48	61,982.0	20	12	379.40		15,763.25	4,200.00			1,860.00	640.00			76,773.45
49	58,983.0	20	11	672.60		1,655.50	4,200.00			1,860.00	640.00			19,768.10
50	66,045.0	20	18	813.00		26,628.68	4,200.00			3,160.00	640.00			43,239.68
51	70,523.0	20	14	105.00		7,322.90				1,860.00	640.00			26,086.90
52	100,135.0	20	20	627.00		14,182.09				2,980.00	640.00			59,855.09
53	81,740.0	20	10	4,580.25		3,188.50				4,820.00	640.00			98,001.04
54	110,664.0	20	22	20,032.80		10,090.31	1,500.00			2,100.00	640.00			128,032.66
55	57,486.0	20	11	46,662.75		5,140.80				1,320.00	320.00			62,630.00
56	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
57	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
58	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
59	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
60	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
61	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
62	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
63	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
64	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
65	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
66	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
67	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
68	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
69	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
70	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
71	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
72	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
73	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
74	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
75	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
76	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
77	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
78	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
79	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
80	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
81	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
82	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
83	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
84	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
85	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
86	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
87	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
88	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
89	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
90	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
91	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
92	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
93	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
94	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
95	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
96	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
97	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
98	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
99	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00
100	57,486.0	20	11	918.20		7,128.90				1,860.00	320.00			62,630.00

[illegible]

MAIN LINE TO ROCK ISLAND.

[illegible]

Estimate for the cost of construction of the Hennepin Canal—Continued.

FEEDER BRANCH.

Miles from Dixon, Ill.	Earthwork.		Culverts.		Bridges.		Cost of aqueducts.	Cost of concrete lining, at \$6 per cubic yard.	Cost of right of way, and special damages.	Cost of fencing, at \$1 per rod.	Special work.	Cost.	Amount.
	Cubic yards.	Price per yard.	Cost.	Cost.	Highway, cost.	Railroad, cost.							
1	64,323.0	\$0.20	\$12,864.00	\$10,280.90	\$2,920.00	\$5,800.00		\$12,000.00		\$320.00	Bulkhead	\$14,242.58	
											Basin	1,258.20	
											Retaining wall	150,045.00	
2	129,007.0	20	25,801.40	2,754.70				6,600.00		320.00	Riprap	5,860.00	\$225,858.28
3	54,236.0	20	10,847.20	8,318.38	5,250.00			3,800.00		320.00	do	11,721.00	52,447.10
4	82,194.0	20	16,438.80	15,083.98				880.00		320.00	do	11,721.80	35,206.58
											do	8,791.00	41,523.78
5	118,865.0	20	23,877.00	1,655.50				4,540.00		640.00	Rock excavation	11,721.00	48,622.50
6	63,548.0	20	12,699.20	1,655.50				1,660.00		640.00	Riprap	11,721.00	26,680.20
7	84,093.0	20	16,819.20	3,311.00				3,820.00		640.00	do	26,841.70	36,941.70
8	79,994.0	20	16,018.80	3,311.00				4,860.00		640.00	do	3,907.00	30,069.80
9	69,633.0	20	13,927.20		7,040.00			3,540.00		640.00	do	5,860.00	26,187.20
10	108,968.0	20	22,361.60	8,210.80				660.00		640.00	Riprap	11,721.00	48,879.40
11	108,968.0	20	21,719.20	8,210.80	4,250.00		\$11,088.00	2,820.00		640.00	do	5,860.00	54,588.00
12	86,313.0	20	17,262.60	13,641.20		7,040.00		2,540.00		640.00	do	42,123.80	42,123.80
13	107,007.0	20	21,501.40	5,509.40	4,250.00			2,100.00		640.00	do	26,851.40	26,851.40
14	137,238.0	20	27,447.20	5,509.40				2,100.00		640.00	do	39,046.60	39,046.60
15	173,015.0	20	34,603.00		4,250.00			1,660.00		640.00	do	35,903.00	35,903.00
16	148,192.0	20	29,639.80		4,250.00			1,660.00		640.00	do	49,047.80	49,047.80
17	117,045.0	20	23,529.00		4,250.00			2,100.00		640.00	do	32,053.70	32,053.70
18	79,048.0	20	15,809.60	2,754.70				2,100.00		640.00	do	22,799.60	22,799.60
19	67,860.0	20	13,472.00	2,754.70				3,100.00		640.00	do	19,996.70	19,996.70
20	103,025.0	20	20,605.00		4,250.00			2,100.00		640.00	do	27,595.00	27,595.00
21	105,983.0	20	21,186.60		4,250.00			2,100.00		640.00	do	26,176.60	26,176.60
22	96,192.0	20	19,338.40	2,754.70	4,250.00			2,100.00		640.00	do	29,583.10	29,583.10
23	105,219.0	20	21,043.90	2,754.70	4,250.00			1,100.00		640.00	do	36,538.50	36,538.50
24	63,947.0	20	12,769.40			7,040.00		1,660.00		640.00	do	15,089.40	15,089.40
25	94,256.0	20	18,851.20	2,044.00				1,660.00		640.00	do	21,151.20	21,151.20
26	118,314.0	20	23,662.80					2,800.00		640.00	do	30,126.80	30,126.80
27	96,399.0	20	19,339.80	1,655.50	4,250.00			3,320.00		640.00	do	33,185.40	33,185.40
28	102,447.0	20	20,489.40		4,250.00			3,320.00		640.00	do	30,175.70	30,175.70
29	108,150.0	20	21,630.00	1,655.50	4,250.00		\$25,190.94	1,520.00		640.00	do	70,619.98	70,619.98

[illegible]

1796 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Summary of estimated cost of enlarging the Illinois and Michigan Canal.

Items.	Amount.	Total.
Section work.....	\$1,541,678 75	.....
Locks.....	448,804 75	.....
Aqueducts.....	39,494 00	.....
Culverts.....	27,600 00	.....
Waste weirs.....	14,349 00	.....
Steam dredge.....	18,000 00	.....
Add 10 per cent. for contingencies.....		\$2,080,926 50
		208,926 50
Grand total.....		2,289,853 00

APPENDIX H H.

IMPROVEMENT OF THE HARBORS AT MICHIGAN CITY AND NEW BUFFALO, LAKE MICHIGAN.

REPORT OF MAJOR JARED A. SMITH, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor at Michigan City, Indiana. | 2. Harbor at New Buffalo, Michigan.
-

(For letter of transmittal see Appendix B B.)

H H 1.

IMPROVEMENT OF HARBOR AT MICHIGAN CITY, INDIANA.

OUTER HARBOR.

The works have been carried on, as in several years previous, under the personal supervision of Capt. J. A. Manning, whose zeal and good judgment entitle him to high commendation.

At the beginning of the year work was in progress constructing a scow for transporting stone to the breakwater. The scow was completed in July, and all work was then suspended, the previous appropriation being exhausted.

The river and harbor act of August 2, 1882, appropriated \$60,000 for continuing this improvement.

As it was late in the season, and materials for construction were yet to be procured, it was impracticable to attempt the completion of the breakwater, although the appropriation was sufficient for the purpose, because it involved the construction of a masonry superstructure late in the autumn, when almost constant winds and frequent storms are to be expected.

The plan for the outer harbor included a pier east of the entrance, the construction of which was of more present importance than any other work in protecting vessels entering the harbor. As the work involved only the usual cribs filled with stone, a project was submitted to construct 150 linear feet of the pier during the autumn of 1882, and to defer until the next season the completion of breakwater, for which it was estimated the remaining funds would be sufficient. Notice of the approval of this plan was received August 17.

As it was then too late in the season to permit any delay in procuring materials, such as were then needed were purchased at once in open market. The timber and stone were purchased after consulting all the principal dealers and obtaining the materials at the lowest prices offered, viz:

Pine timber, per 1,000 feet, \$14.50; hemlock timber, per 1,000 feet, \$14.50 and \$15; stone, per cord, \$5.50, on board scows in Chicago.

The stone was brought from Chicago upon the new scows built for that purpose, at a total expense of \$2 per cord for towing. The lowest price obtained for towing before the scows were built was \$1.35 per cord, besides the necessity for one extra handling of the stone.

All the work of construction has been carried on by hired labor.

On the 30th of November the 150 feet of pier was completed, save decking the top, which could not be done until spring, owing to the frequent and severe storms.

The pier is constructed of the same dimensions and in the same manner as the last cribs of breakwater.

An experience of three years has fully confirmed the usefulness as well as the ultimate economy of the method used, though it is more expensive at first than the designs formerly used. The matter is of such importance that I quote the following from my annual report of 1881:

The method adopted for constructing and securing cribs has been an entire success. The crib shown in drawings with annual report for 1879 (Report of Chief of Engineers, 1879, opposite page 1558) had been found to be so strong as to resist the heaviest storms ever experienced without the slightest injury. It, however, requires great weight or some other force to hold it upon the pile foundation during severe storms. Although this method permits the superstructure to follow immediately after the cribs have been sunk, a short length must always be more or less incomplete during the working season. This condition of the breakwater and the effect of a severe storm was minutely described in the last annual report. (Report of Chief of Engineers, 1880, page 2004.)

To prevent the sliding of cribs when nearly emptied of stone by a storm, the arrangement of vertical timbers in the angles formed by the cross-walls, and the sea face has been so modified that one timber of each pair is driven down as a pile. The piles are held firmly into the angles so that they slide down like a dredge spud; they are driven through the sand into the substratum of clay, and the upper portion is then bolted to the superstructure.

With this arrangement some severe storms have been experienced without the slightest motion of the cribs upon their foundation.

REPAIRS.

Besides the ordinary repairs of machinery, scows, and other plant extraordinary repairs have been required upon the breakwater and pier.

On the 2d of December a severe gale did considerable injury to the work, but as it was immediately followed by very cold weather, the breakwater became covered with ice, which remained until well into April; it was then found that one hundred and sixty pieces of the deck plank had been broken or torn away, and that the stone had settled considerably in a large number of compartments on the north side, and had disappeared entirely in a few.

The repairs to breakwater are not yet complete, although the expense has been as follows:

28,015 feet pine, at \$14.50 per M.....	\$415 25
2,304 feet hemlock, at \$14.50 per M.....	33 40
2,475 pounds spikes, at 4 cents.....	99 00
80 pounds bolts, at 3 cents.....	2 40
261 cords stone, at \$8.50.....	2,218 50
Labor.....	607 00
Total	3,379 10

DREDGING.

Bars having formed in the main channel in October, it became necessary to remove them by dredging.

The necessity was too urgent to permit any delay, as loaded vessels were constantly arriving, and were submitted to danger in stormy weather and inconvenience at all times; a dredge was therefore employed at \$60 per day, and the Government, in addition, towed the material to the dumping grounds.

The amount removed was 6,504.3 cubic yards, costing twenty days of dredge, at \$60.....	\$1,200
Towing material, one hundred and thirty-one hours, at \$4.....	524
Total.....	1,724

The total cost was, therefore, about 26.5 cents per cubic yard.

PURCHASES.

October 2, advertisements were issued for proposals to furnish 668,196 feet of hemlock and 139,968 feet of pine timber; the following proposals were received:

Names and addresses of bidders.	Hemlock.	Piles.	Pine.	Plank.
	<i>Per M. B. M.</i>	<i>Per M. B. M.</i>	<i>Per M. B. M.</i>	<i>Per M. B. M.</i>
Albert H. Petrie and Hiram M. Gilman, known as A. H. Petrie & Co., Muskegon, Mich.	\$12 75	\$12 75 each 5.408	\$15 75	\$15 75
Alfred S. Packard, Covert, Mich.	14 50	each 6 20	19 00	15 50
Russell K. Bickford, and Reuben Knox, known as Bickford, Knox & Co., Chicago, Ill.	15 50	8 63	16 75	14 00

A contract was duly entered by A. H. Petrie & Co., of Muskegon, Mich., to deliver the timber on or before June 15, 1883.

Owing to an extensive fire which consumed the mills of Petrie & Co. as well as a large amount of lumber ready for delivery, the contract has been extended to July 15. Nearly all the lumber under the contract has been delivered.

In the purchase of the iron necessary for drift-bolts to complete the breakwater written proposals were obtained as follows for iron delivered at Michigan City:

Names and addresses of bidders.	Drift bolts.	Screw-bolts.
	<i>Per pound.</i>	<i>Per pound.</i>
Haskell & Barker Car Company, Michigan City, Ind.	\$02.25	\$03
S. D. Kimbark, Chicago, Ill.	2.50	3.75
F. K. Bowes, Chicago, Ill.	2.30	3.65
Chicago Forge and Bolt Company, Chicago, Ill.	2.34	3.22½
Charles L. Wickersham & Co., Chicago, Ill.	2.30	3.5

The drift-bolts were cut to lengths without heads or points.

The iron was purchased of the Haskell and Barker Car Company at the prices given in their proposal.

During the winter a blacksmith and helper were employed in heading and pointing bolts and in repairing various tools.

PROJECT FOR ENSUING YEAR.

Owing to the absence of any appropriation for the ensuing year it became impracticable to carry out the entire project for expending the last appropriation; this was because injuries from storms had already entailed an expense of \$5,000, and because still greater contingencies must be expected during the ensuing year for which it would be suicidal not to reserve funds; besides these there is the care of plant, and other incidental expenses which cannot be avoided without the still greater loss which the sale of the plant and abandonment of the work would entail; so that the entire contingent expenses of two years must be paid from the appropriation for one.

So long as the appropriations do not justify the dredging of the outer harbor to afford an anchorage, the completion of the present breakwater is less essential than the improvement of the entrance.

It has therefore been found advisable to extend the entrance pier 100 feet the present season, and to reserve any remaining funds to repair injuries or meet such other contingencies as may arrive before the subject can be further considered by Congress.

CONDITION OF THE WORK.

The entrance, though narrow, and consequently somewhat hazardous to vessels in violent winds, is deep enough to permit the passage of the largest lake craft; such vessels can proceed with loads to any part of the harbor save that which was originally designed for a refuge and anchorage. For reasons which have been fully stated in the various reports the outer basin is still incomplete, requiring, besides the small piece of breakwater, the removal of about 450,000 cubic yards of sand by dredging.

The west pier is almost entirely rotten, and a part of it must have been swept away during the last winter, had it not been heavily loaded with stone which had been stored for use in the breakwater.

A recent examination of the breakwater led to the conclusion that at least 20 per cent. of the plank covering, which had been exposed but five years, was sensibly affected by decay.

It is fair to presume that in five years more the reconstruction of the superstructure must be commenced, either as extensive repairs or rebuilding entire.

FUTURE REQUIREMENTS.

The outer harbor is much too small, even when complete, to serve the purpose for which it was designed, and to remedy its defects designs were made and received the approval of a Board of Engineers. (See plan opposite page 2270, Report of Chief of Engineers, 1880; also page 2263 to 2270, inclusive.)

The new breakwater should be commenced at an early day. The situation cannot be too strongly urged. The west pier cannot possibly protect the entrance to the business portion of the harbor but a few years longer unless essentially rebuilt; such a rebuilding would permanently cramp the outer harbor, and maintain the present narrow and dangerous entrance which has caused many vessels to be wrecked. (See list of wrecks, page 2269, Report of Chief of Engineers, 1882, Appendix G G.)

The new breakwater, if built soon enough, will remedy these evils, and will largely increase the usefulness of the harbor by making it a safe refuge, the only one at the southern extremity of the lake. With

neither of these works the usefulness of the harbor must be entirely destroyed in a very few years. (See map opposite page 2270, Report of Chief of Engineers, 1882.)

MASONRY SUPERSTRUCTURE.

The pine timber in the superstructure of these works has been carefully selected, yet its decay is so rapid that it cannot be relied upon for more than ten years where strength is required. Even at its best the timber and plank are frequently broken, so that any process of preserving the wood would not entirely remedy the evil, although greatly increasing the expense.

A device for a superstructure of masonry has therefore been made, and it is proposed to complete the 166 feet of breakwater with this kind of work, its use being partly experimental.

As the construction of the cribs, especially in securing to foundations, presents features not heretofore used, a copy of the design is submitted as part of this report.

It is proposed to apply any funds which may be appropriated for the year ending June 30, 1885, to complete the breakwater; to complete the pier east of entrance, or to commence the new breakwater, as may then seem most necessary.

The dredging in outer basin is of less present importance than the new breakwater, owing to the urgent necessity for securing a protection on the west side before the old west pier shall have become too weak to serve the purpose any longer.

ESTIMATES.

The estimated amount to complete the old and new breakwater and piers is \$475,000.

Somewhat less than the full amount of the last appropriation has been deducted from the estimate in last annual report, owing to repairs of old work and maintenance of channel.

It would be economy in the prosecution of the work to appropriate a sum not less than \$200,000 for single year, and this sum is therefore asked for the fiscal year ending June 30, 1885.

Money statement.

July 1, 1882, amount available.....	\$1,011 50
Amount appropriated by act passed August 2, 1882.....	60,000 00
	<hr/> 61,011 50
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$35,007 53
July 1, 1883, outstanding liabilities.....	6,536 52
	<hr/> 41,544 05
July 1, 1883, amount available.....	19,467 45
	<hr/> Amount (estimated) required for completion of existing project..... 475,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	200,000 00

INNER HARBOR.

The work was entirely suspended in July, 1882, the whole amount of the previous appropriation having been expended.

The act of August 2, 1882, appropriated \$20,000 for continuing the improvement, and the work of extending the harbor by dredging the creek was resumed August 15.

The dredging has been done by hired labor, using the machine pertaining to the improvement.

The channel has been extended its full width over 700 feet, besides being deepened at several places where it had filled.

The amount dredged during the year is more than one-third of the entire amount required to be done at the beginning of the year.

The total amount of material excavated has been 111,590 cubic yards, of which 52,990 were cast up to fill the quay, and 58,600 were taken out in scows and dumped in the lake.

The entire expense has been \$11,097.51, an average of less than 10 cents per cubic yard.

The expense of towing was \$3,856, nearly 6.6 cents per cubic yard; and putting all other items of every kind into the cost of excavation, it has amounted to a little less than 6.4 cents per cubic yard, the same rate as during the previous year. This includes the cost of timber and partial construction of a new dump-scow, office expenses, and in fact everything paid from the appropriation.

The lowest price ever obtained by contract for the same work on this improvement is 18 cents per yard, which includes no contingent expenses; add the salary of an inspector and office expenses, and the ultimate price by contract becomes more than three times the amount which it is costing the Government to do the work with its own appliances and hired labor.

No better comment on the two systems is required, especially when it is added that owing to the working of the eight-hour law the Government is required to pay its mechanics and laborers considerably more for the same labor than is paid by contractors or other private parties.

The channel is now entirely clear as far as the upper winding basin, and the dock cuts of the basin are completed. The length of the inner harbor is now 6,500 feet, with more than 2 miles of available wharf room.

It is estimated that an additional appropriation of \$15,000 will be sufficient to complete the work according to the plan. This makes a total of \$5,000 more than the estimate with the last annual report. The small excess is due to filling in the channel, and some other contingencies which cannot be foreseen in making an estimate.

Money statement.

July 1, 1882, amount available.....	\$406 06
Amount appropriated by act passed August 2, 1882	20, 000 00
	<hr/> 20, 406 06
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$9, 905 31
July 1, 1883, outstanding liabilities.....	1, 192 20
	<hr/> 11, 097 51
July 1, 1883, amount available.....	9, 308 55
	<hr/> 15, 000 00
Amount (estimated) required for completion of existing project.....	15, 000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	15, 000 00

COMMERCIAL STATISTICS.

Michigan City is in the collection district of Chicago, Ill. Nearest light-house is at the entrance of the harbor of Michigan City.

The harbor is an extensive distributing point for lumber, which goes to the States of Indiana, Kentucky, Illinois, Missouri, and Kansas; and its facilities for handling cheapen the price of lumber in all those States.

Owing to certain combinations among manufacturers, which have affected Chicago and other markets in a similar proportion, the receipts during the last year were somewhat less than in the year immediately preceding.

The principal receipts by water were the following:

Vessels entered.....	708
Vessels cleared.....	708
Lumber.....	feet, B. M.. 112, 076, 865
Lath.....	number.. 35, 921, 350
Shingles.....	do.. 106, 050, 279
Pickets.....	do.. 213, 000
Coal.....	tons.. 500
Pig iron.....	do.. 3, 766
Stone.....	cords.. 2, 000

Exports:

Hay.....	tons.. 500
Sand.....	cubic yards.. 2, 000

In addition to the above there has been a large amount of miscellaneous freight, of which no record can be obtained, and also a large number of passengers.

Michigan City Harbor also affords shelter for a fleet of small tugs and fishing vessels, in which an extensive capital is invested.

H H 2.

IMPROVEMENT OF HARBOR AT NEW BUFFALO, MICHIGAN.

The river and harbor act of August 2, 1882, appropriated \$5,000 for improving this harbor.

In accordance with the requirements of a resolution of the House of Representatives of the United States, dated February 21, 1882, a report was submitted February 28, 1882 (see Annual Report, Chief of Engineers, 1882, page 2278), estimating the expense of making a harbor at this place of sufficient capacity to accommodate the commerce of the lakes at \$150,500.

The appropriation made can be of but little use, for it is insufficient to produce any material benefit to the harbor or its commerce, being less than one-thirtieth of the estimate, and it is safe to say that an equal appropriation annually would never complete the work, because in a few years the small appropriations would be exhausted in maintaining the partly-protected channel, repairing the incomplete constructions, and in other inevitable contingent expenses.

In accordance with instructions from the Chief of Engineers, dated August 8, 1882, a project, with estimate of cost, was submitted for this improvement.

The project was to extend the east pier 100 feet, in accordance with the plan submitted in the report of February 28, 1882, already mentioned.

The estimated cost covered the entire amount appropriated, viz, \$5,000.

No approval of this project has been received, no expense has been incurred, and none of the appropriation has been drawn from the Treasury.

The present harbor is in the mouth of a small stream, known as Galien River. The east side is protected a short distance by an old pier erected by the Government about 11 years ago and since repaired. Vessels drawing less than 3 feet of water can generally, though not always, cross the bar at the mouth of this stream.

The harbor of New Buffalo is in the collection district of Chicago; the nearest light-house and port are at Michigan City, Ind., 10 miles distant.

There are no commercial statistics of sufficient value to report.

Money statement.

Amount appropriated by act passed August 2, 1882.....	\$5, 000
July 1, 1883, amount available.....	5, 000

APPENDIX II.

IMPROVEMENT OF HARBORS ON THE EASTERN SHORE OF LAKE MICHIGAN AND OF GRAND RIVER BELOW GRAND RAPIDS.

REPORT OF CAPTAIN D. W. LOCKWOOD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|--|------------------------------------|
| 1. Charlevoix Harbor, Michigan. | 8. Muskegon Harbor, Michigan. |
| 2. Frankfort Harbor, Michigan. | 9. Grand Haven Harbor, Michigan. |
| 3. Harbor of Refuge at Portage Lake, Michigan. | 10. Grand River, Michigan. |
| 4. Manistee Harbor, Michigan. | 11. Black Lake Harbor, Michigan. |
| 5. Ludington Harbor, Michigan. | 12. Saugatuck Harbor, Michigan. |
| 6. Pent Water Harbor, Michigan. | 13. South Haven Harbor, Michigan. |
| 7. White River Harbor, Michigan. | 14. Saint Joseph Harbor, Michigan. |
-

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., August 13, 1883.

GENERAL: I have the honor to submit herewith my annual reports for the works of river and harbor improvement under my charge (since April 1, 1883) for the fiscal year ending June 30, 1883.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

III.

IMPROVEMENT OF CHARLEVOIX HARBOR, MICHIGAN.

Operations for the improvement of this harbor were discontinued with the close of navigation in the fall of 1881, and were not resumed until the 13th day of June, 1883. They are now being carried on under contract with Mr. Luther E. Allen, of Charlevoix, Mich., dated November 24, 1882, with funds appropriated August 2, 1882.

Mr. Allen's contract calls for the conversion of 440 feet of close piling on the south side of the channel into plank beam revetment; building

600 linear feet of plank beam revetment, with edgings and cedar bark or brush backing, and dredging in the channel to the extent of 10,000 cubic yards.

Owing to stormy weather, the season was far advanced before the contractor was able to procure a dredge with which to prepare site for new work.

The contractor is now making rapid progress with his work and will probably complete his contract during the month of July, 1883. He has already completed dredging, having removed, in all, 10,306 cubic yards of sand and gravel, of which 4,920 yards was removed from the site of proposed new work, and 5,386 yards from the channel, near the mouth of harbor.

The dredging has resulted in a narrow channel along the axis of the piers, of not less than 12½ feet depth. He has also completed the revetment on south side of channel and built 359 linear feet of revetment at foot of bluff, on north side, making, in all, 789 linear feet constructed since the commencement of work under his contract.

Further work under an extension of contract will be limited to the lower channel, and instead of placing 250 linear feet of detached revetment in the upper channel, as was intended, the works already constructed for the protection of the lower channel will be backed, as far as the funds on hand will allow, by a complete filling of edgings or brush.

During the month of April, 1883, a survey of both the upper and lower channels was made. It was found that while the upper channel was available for vessels drawing 12 feet of water, soundings of only 10 feet were found at the outer end of the lower channel, or at the entrance to the harbor. This channel, as already stated, has been partially relieved by dredging.

It is proposed, therefore, while keeping the general project in view for the maintenance of both channels, to complete the lower channel and give a navigable depth of at least 12 feet. To accomplish this will require the further extension of piers and completion of dredging between the piers at entrance to harbor.

It is estimated that \$40,000 can be profitably expended for this purpose during the fiscal year ending June 30, 1885, and it is respectfully recommended that this amount be appropriated.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich. The nearest light-house is Grand Traverse.

Original estimated cost of work, 1868.....	\$198,044 14
Amended in 1876	186,000 00
Whole amount appropriated 1868 to 1883, inclusive	61,000 00
Amount expended.....	56,134 68

Money statement.

July 1, 1882, amount available.....	\$39 17
Amount appropriated by act passed August 2, 1882	10,000 00
	<hr/> 10,039 17
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$655 90
July 1, 1883, outstanding liabilities.....	4,567 87
	<hr/> 5,223 77
July 1, 1883, amount available.....	<hr/> 4,865 40
Amount (estimated) required for completion of existing project.....	125,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	40,000 00

bor, Mich.

83



D.W. Lathrop
and J. J. Lathrop

Lake

Round



Abstract of bids received and opened October 28, 1882, by Maj. D. P. Heap, Corps of Engineers, for improving harbor at Charlevoix, Mich.

Material.	1. Green Bay Dredge and Pile-Driver Co., Christian Schwarz, president, Green Bay, Wis.	2. Carlin, Stickney & Crum, East Saginaw, Mich.	3. Dowland & Moore, Ludington, Mich.	4. Luther E. Allen, Charlevoix, Mich.
Piles in place.....per linear foot.....			\$0 35	Pine, \$0 18 Hemlock, 16
Timber in place, B. M.....per M feet.....			40 00	Pine, 29 00 Hemlock, 20 00
Pine plank, selected in place, B. M....do.....			40 00	Pine, 20 00 Hemlock, 16 00
Pine plank, contractors option, in place, B. M.....per M feet.....			30 00	15 00
Screw and washer-bolts, in place...per pound.....			10	08
Drift-bolts in place.....do.....			06	06
Wrought spike, in place.....do.....			10	08
Cut nails, in place.....do.....			10	06½
Stone, in place.....per cord.....			12 00	6 00
Brush, in place.....do.....			10 00	3 00
Cedar bark, in place.....do.....			10 00	5 00
Edgings, in place.....do.....			8 00	3 00
Dredging.....per cubic yard.....	\$0 29	\$0 27		*25
Total of material in place.....			10,339 20	*5,288 82

*Award recommended.

Contract with Luther E. Allen, dated November 24, 1882, expiring June 30, 1883 (extended to September 15, 1883).

Tabulated statement of commercial statistics, Charlevoix Harbor, Michigan, from July 1, 1882, to June 30, 1883.

Year ending—	Vessels entered and cleared.	Revenue collected.
June 30, 1883.....	697	\$1,168 47

I I 2.

IMPROVEMENT OF FRANKFORT HARBOR, MICHIGAN.

By day labor and purchased material the repairs to the inner end of the north pier were completed early in the fall of 1882. These repairs resulted in extending the inner end of the 30 feet, and in renewing and re-enforcing the adjacent pile revetment for a length of 25 feet.

This was one of the harbors selected by a Board of Engineer Officers, under Special Orders No. 65 (series of 1882), for testing the merits of the modified crib superstructure proposed by Maj. D. P. Heap, Corps of Engineers, United States Army, then in charge of the work.

During the month of November, 1882, the material for the construction of 100 linear feet of modified superstructure over the two cribs sunk in extension to the south pier in 1882 was purchased and delivered.

Owing, however, to continuous stormy weather and the exposed position of the work, but little progress could be made, and the work was closed for the season on the last day of November, 1882, after building two courses of superstructure and protecting the same by a row of fender piles, driven 4 feet apart along the channel side of crib. These piles were topped and capped in accordance with the recommendation of the Board of Engineer Officers.

Work on the modified superstructure was resumed by day labor on the 17th day of May, 1883, and is now completed.

The new work presents a very creditable appearance, and has effected a saving of about \$700 to the harbor.

Proposals were invited, under date of September 18, 1882, and resulted in a contract with Messrs. Dewar & Wing, of Ludington, Mich., for pier construction, and with the Green Bay Dredge and Pile-Driver Company, of Green Bay, Wis., for dredging in the channel.

The latter contract was completed June 13, 1883, the contractors having removed 10,028 cubic yards of material, which resulted in a channel 100 feet wide and not less than 13 feet deep.

Messrs. Dewar & Wing have built and sunk a 50 by 30 by 18½ foot crib in extension to the south pier, on a pile foundation. Further work under their contract will be limited to the construction of two courses of superstructure upon the new crib, which will prepare the crib for the reception of the modified superstructure, if, after a thorough test, it is thought advisable to continue its construction.

The superstructure to the 900 feet of pile revetment is rapidly falling to decay, and should be renewed with as little delay as possible. The pile-work under water is still sound and intact, and if the work is undertaken at once will be available as a foundation for the new superstructure.

The estimated cost of this work is \$5,000, and it can be best done by hired labor and material purchased in open market.

Further work at this harbor will, under the approved project, consist in pier extension, dredging to maintain existing channel, and in repairs. It is estimated that \$50,000 can be profitably expended for this purpose during the fiscal year ending June 30, 1885, and it is respectfully recommended that this amount be appropriated.

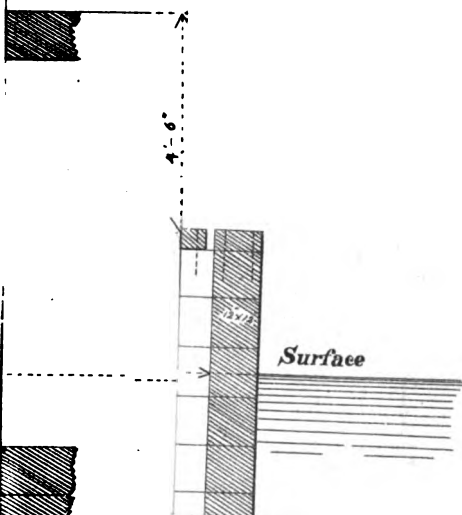
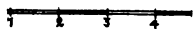
This work is in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich. The nearest light-house is at Point Betsy (Point Aux Becs Scies). A light is shown near head of south pier.

Original estimated cost of work, 1866, amended in 1875 and again in 1879.	\$254, 196 00
Whole amount appropriated from 1866 to 1883, inclusive.....	243, 659 85
Amount expended	227, 483 49

Money statement.

July 1, 1882, amount available.....	\$1, 176 36
Amount appropriated by act passed August 2, 1882	15, 000 00
	<hr/> 16, 176 36
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$6, 644 97
July 1, 1883, outstanding liabilities	4, 110 58
	<hr/> 10, 755 55
July 1, 1883, amount available.....	5, 420 81
	<hr/> 85, 000 00
Amount (estimated) required for completion of existing project.....	50, 000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	50, 000 00

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Abstract of bids received and opened October 28, 1882, by Maj. D. P. Heap, Corps of Engineers, for improving harbor at Frankfort, Mich.

Material.	1. Green Bay Dredge and Pile-Driver Company; Christian Schwab, president, Green Bay, Wis.	2. Cartin, Stickney & Cram, East Saginaw, Mich.	2. Green's Dredging Company, O. B. Green, president, Chicago, Ill.	4. Dewar & Wing, Ludington, Mich.	5. George Talbot, Buffalo, N. Y.
Foundation piles, hard wood, 324 linear feet, per foot				\$2 00	\$1 50
Sheet piles, white oak, 2,304 linear feet, per foot				75	50
Hemlock timber, 67,564 feet, B. M. per M feet				30 00	30 00
Pine timber, 22,386 feet, B. M. do				40 00	40 00
White-oak timber, 672 feet, B. M. do				75 00	50 00
Pine plank do				40 00	30 00
Screw-bolts, complete, 1,166 pounds per pound				10	08
Drift-bolts and straps, 9,752 pounds do				10	08
Spikes, 415 pounds do				10	08
Stone, 180 cords per cord				15 00	15 00
Cedar bark, or brush, 17 cords do				10 00	10 00
Shingle shavings do				5 00	5 00
Dredging per cubic yard	*\$0 24	\$0 30	\$0 29½		50
Total				9,352 66	8,167 86

* Award recommended.

NOTE.—All bids for pier construction were rejected on account of being excessive.

Abstract of bids received and opened November 18, 1882, by Maj. D. P. Heap, Corps of Engineers, for improving harbor at Frankfort, Mich.

Materials.	1. George Talbot, Buffalo, N. Y.	2. Thomas Collister, Pentwater, Mich.	3. Dewar & Wing, Ludington, Mich.
Foundation piles, hard wood, 324 linear feet per lin. foot	\$1 50	\$1 20	\$1 50
Sheet piles, white oak, 2,304 linear feet do	50	40	40
Hemlock timber, 67,564 feet, B. M. per M feet	35 00	30 00	24 00
Pine timber, 22,386 feet, B. M. do	40 00	34 00	35 00
White-oak timber, 672 feet, B. M. do	50 00	45 00	50 00
Pine plank do	30 00	34 00	35 00
Screw-bolts, complete, 1,166 pounds per pound	08	10	10
Drift-bolts and straps, 9,752 pounds do	06	06	05
Spikes, 415 pounds do	06	07	06
Stone, 180 cords per cord	15 00	12 00	12 00
Cedar bark or brush, 17 cords do	10 00	6 00	6 00
Shingle shavings do	5 00	6 00	3 00
Dredging per cubic yard	1 50		
Total	8,505 78	7,528 85	*6,737 83

* Award recommended.

Contract with Dewar & Wing, of Ludington, Mich., dated December 6, 1882, expiring June 30, 1883, for pier construction.

Contract with Green Bay Dredge and Pile-Driver Company, of Green Bay, Wis., dated November 28, 1882, expiring June 30, 1883, for dredging, at 24 cents per cubic yard of material dredged and removed, as measured in the dump scows.

Tabulated statement of commercial statistics, Frankfort Harbor, Michigan, from July 1, 1882, to June 30, 1883.

Year ending—	Vessels entered and cleared.	Revenue collected.
June 30, 1883	499	\$423 92

MODIFICATION OF CRIB SUPERSTRUCTURE PROPOSED BY MAJOR D. P. HEAP, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., June 29, 1882.

GENERAL: I have the honor to inclose herewith tracing of "modified crib superstructure," which I have designed for the purpose of reducing the cost of the present system and still be equally as efficacious.

The plan is so simple that it requires but little explanation beyond the tracings; there is one point, however, to which I wish to draw attention, namely, that when a wave strikes the structure the impact of the lower part is received by the crib proper, while the upper part, after an interval of time, strikes the inclined wall; thus the force of the blow is divided, while the whole structure offers its resistance to each part.

The inclination of the walls is also an advantage, as the shock from floating ice and driftwood will not be so great as if they were upright.

The deck planks are made heavier than usual, also, to withstand the shock from floating objects.

In places where the cribs are exposed to the waves from one direction only, the heavy longitudinal timber on the opposite side may be replaced by lighter ones, or perhaps omitted altogether.

I respectfully ask authority to apply this modification to one crib at Pent Water and to two cribs at Frankfort, these two harbors being the ones which are, respectively, the least and most exposed of any of which I have charge north of Grand Haven.

The saving on each crib is in round numbers about \$600. Should the plan prove successful, and be universally adopted on the lakes, the saving will amount up into the hundreds of thousands of dollars.

Even should it fail, the cost of the experiment is not great, and the superstructure can be rebuilt as heretofore.

I would like to commence the work at once by purchased material and days' labor.

I inclose a tracing and estimates of the cost of superstructure as modified and as heretofore built.

Very respectfully, your obedient servant,

D. P. HEAP,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

Estimated cost of seven courses of superstructure for a crib 50 by 30 feet.

Material.	Quantities.	Cost.
Timber:		
Pine timber, in the work (1,002 linear feet), at \$30 per M feet, B. M.	22,704	
Pine plank, for decking, 3 by 12 inches, at \$30 per M do	2,750	
	25,454	\$763 42
Iron:		
815 drift-bolts, 22 by 1 inch square, at 7 cents per pound pounds..	3,150	
525 ship-spikes, 7 by 1/2 inches, at 7 cents per pound do	75	
	3,225	225 75
Stone:		
In the work, at \$12 per cord cords..	62	744 00
		1,708 17
Contingencies, 10 per cent		170 24
Total		1,900 71

Respectfully submitted.

D. P. HEAP,
Captain of Engineers.

Estimated cost of modified superstructure 7 feet high for a crib 50 by 30 feet.

Material.	Quantities.	Cost.
Timber:		
Oak, in the work (75 linear feet), at \$40 per 1,000 M feet, B. M.	900	\$36 00
Pine, in the work (1,522 linear feet), at \$30 per 1,000 M do	18,264	
Decking, in the work (384 linear feet), at \$30 per 1,000 M do	4,608	
	22,872	686 16
Iron:		
Boiler-plates, 5 by 24 by $\frac{3}{8}$ inches, at 10 cents per pound pounds	184	
Screw-bolts, with nuts and washers, $1\frac{1}{2}$ by 40 inches, at 10 cents do	600	
	784	73 40
Drift-bolts, 32 by 1 inch, at 6 cents per pound pounds	2,240	
Drift-bolts, 20 by 1 inch, at 6 cents per pound do	900	
Drift-bolts, 15 by 1 inch, at 6 cents per pound do	800	
	3,440	206 40
Stone:		
In the work, at \$12 per cord cords	16	192 00
Contingencies, 10 per cent.....		1,198 96
		119 90
Total.....		1,818 86

Respectfully submitted.

D. P. HEAP,
Captain of Engineers.

REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., July 20, 1882.

GENERAL: The Board of Engineer Officers constituted by Special Orders No. 65, current series, from Headquarters Corps of Engineers, to consider and report upon the proposed modification of the cribs for the piers at Pentwater and Frankfort, Mich., met at Grand Rapids July 20, with all the members present, and have the honor to submit the following report:

The president of the Board submitted the copy of instructions from the Chief of Engineers, United States Army, with a tracing of the proposed modification of the piers and letter of Maj. D. P. Heap, explanatory of the same.

Major Heap appeared before the Board and explained the various details of the project.

After discussion, the Board expressed the opinion that the height of 3 feet of the channel side of the pier above the water surface was too small, there being a likelihood that vessels would in severe gales be in danger of riding the pier, and therefore some means should be interposed to avert such a disaster.

The Board considered that the objection could be overcome by oak piles placed 4 feet apart from center to center, the piles being 4 feet from the piers and capped with a waling piece of oak, the top of which should be about 6 feet above the water surface. This pile protection, in addition to overcoming the objection above mentioned, will also protect the piers from injury caused by collisions. The estimated cost of this additional construction will not exceed \$3 per linear foot of pier, or \$150 for each crib.

With this modification the Board would respectfully recommend the trial of the modified plan of superstructure proposed by Major Heap at the harbors of Pentwater and Frankfort.

There are returned herewith the tracing of the proposed construction and Major Heap's project, with comparative cost of both methods of construction.

Respectfully submitted.

D. C. HOUSTON,
Major of Engineers, Bvt. Colonel.
JARED A. SMITH,
Major of Engineers.
W. H. H. BENYAURD,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

III 3.

HARBOR OF REFUGE AT PORTAGE LAKE, MICHIGAN.

Operations for the improvement of this harbor were suspended on the 30th day of June, 1882. The work was resumed on the 28th day of August, under the appropriation of August 2, 1882.

For reasons stated in Annual Report of 1881, the work at this harbor has been carried on by day labor and with material purchased in open market.

Continual repairs during the year have been needed upon the piers, more especially at the outer ends, where, owing to their exposed position, there has been a constant settlement of the filling. These repairs have consisted in overhauling and refilling the piers with edgings, brush and stone, and have caused a constant drain on the appropriation.

On account of the exposed position, and the late date on which the funds became available, it was found impossible to protect the outer ends of the piers by close-piling or crib-work, as was intended. They were, therefore, made as secure as possible for the winter, by sheathing both sides, building up and strengthening the superstructure, and decking over after the filling had been replaced and weighted down with stone.

During the month of June the outer ends of both piers were taken in hand, and the south pier-head protected by a row of close-piling, driven along the end and on both sides, and fastened with screw and washer bolts to the superstructure of the pier.

A crib 50 by 24 by 16½ feet was built and sunk at the outer end of the north pier. Superstructure will be placed over this crib as soon as it has settled to a firm foundation.

On the 25th of September the United States dredging apparatus was sent to this harbor for the purpose of preparing a trench for the proposed inner extension of the north pier.

Six thousand one hundred and eighty cubic yards of sand were dredged from the site of north pier, and 24,350 cubic yards from two cuts made along the south side of the north pier.

The dredging has resulted in a temporary channel 9½ feet deep and 50 feet wide.

A channel of not less than 6½ feet depth was maintained throughout the year, for the better prosecution of work and to assist local navigation, which is beginning to be of considerable importance.

Upon the completion of inner extension, the north pier will be 1,415 feet in length. The length of the south pier remains 575 feet, same as last report.

Further operations at this harbor will, under the approved project, consist in completing the inner extension of south pier, in crib-work for the outer extension of both piers, and in completing the dredging between the piers.

The following estimate is for work that can be done to advantage during the fiscal year ending June 30, 1885:

(1) Extending inner end of south pier 900 feet	\$20,000
(2) Dredging between piers	18,000
(3) Outer extension of piers, 500 feet each	80,000
(4) Repair and contingencies	22,000
Total	140,000

And it is respectfully recommended that this amount be appropriated. Sound economy clearly indicates that liberal appropriations should be made for this work.

This work is in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, and the nearest light-house is the Manistee light.

Original estimated cost of work, 1879	\$189,860 00
Whole amount appropriated from 1879 to 1883, inclusive	55,000 00
Amount expended	44,886 17

The estimated amount required for the entire and permanent completion of the work in accordance with the project adopted is indeterminate.

Money statement.

July 1, 1882, amount available	\$315 84
Amount appropriated by act passed August 2, 1882	25,000 00
	<hr/> 25,315 84
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$10,846 88
July 1, 1883, outstanding liabilities	4,355 13
	<hr/> 15,202 01
July 1, 1883, amount available	10,113 83
	<hr/> Amount that can be profitably expended in fiscal year ending June 30, 1885. 140,000 00

I I 4.

IMPROVEMENT OF MANISTEE HARBOR, MICHIGAN.

The contract of Mr. Duncan Dewar, of Ludington Mich., dated July 1, 1881, was closed by completion early in the month of July, 1882, the remainder of the stone filling having been put in place and the new work docked over.

This contract has resulted in extending the south United States pier 50 feet by the addition of one crib 50 by 30 by 24½ feet on a stone foundation. Also placing 150 linear feet of superstructure on the three cribs sunk in 1880 in extension to the north pier.

Under the appropriation of August 2, 1882, sealed proposals were invited for the extension of the south pier by a 50 by 30 foot crib to be sunk on a pile foundation; also for dredging the channel.

The Green Bay Dredge and Pile-Driver Company, of Green Bay, Wis., were the lowest bidders for dredging and are now under contract. They have the work well in hand and will probably complete it during the month of July.

1814 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Messrs. Dewar & Wing, of Ludington, Mich., were awarded the contract for pier extension. On account of rough weather they have been detained with their work at other harbors. They will, however, commence the work early in July under an extension of contract, and will probably complete it early in the month of August.

Further operations for the improvement of this harbor will consist of dredging and pier extension, with a view of obtaining and securing a depth of 12 feet, as contemplated in the original project. It is estimated that \$50,000 can be profitably expended for this purpose during the fiscal year ending June 30, 1885, and it is respectfully recommended that this amount be appropriated.

This work is in the Michigan collection district. The nearest port of entry is Grand Haven, Mich. A light is shown near the head of south pier.

Original estimated cost, 1866, amended 1875	\$234,000 00
Whole amount appropriated 1866 to 1883, inclusive	218,000 00
Amount expended	203,689 29

The estimated amount required for the entire and permanent completion of the improvement in accordance with the adopted project is indeterminate.

Money statement.

July 1, 1882, amount available	\$3,583 46
Amount appropriated by act passed August 2, 1882	15,000 00
	18,583 46
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$3,322 32
July 1, 1883, outstanding liabilities	950 41
	4,272 73
July 1, 1883, amount available	14,310 73
Amount that can be profitably expended in fiscal year ending June 30, 1885	50,000 00

Abstract of bids received and opened October 28, 1882, by Maj. D. P. Heap, Corps of Engineers, for improving harbor at Manistee, Mich.

Materials.	* 1. Green Bay Dredge and Pile- Driver Company, Christian Schwarz, president, Green Bay, Wis.	2. Carlin, Stickney & Cran- East Saginaw, Mich.	3. Green's Dredging Company, O. B. Green, president, Chi- cago, Ill.	4. Truman & Cooper, Manito- woc, Wis.	5. Tully H. Smith, Milwaukee, Wis.	* 6. Dewar & Wing, Ludington, Mich.	7. George Talbot, Buffalo, N. Y.
Piles, foundation, in place.....per lin. ft.						\$2 00	\$1 50
Piles, sheet, white oak, in place.....do.						50 00	50 00
Timber, white oak, in place.....per M ft.						50 00	50 00
Timber, hemlock, in place.....do.						40 00	40 00
Timber, pine, in place.....do.						40 00	40 00
Fine plank in place.....do.						08 00	08 00
Screw and washer bolts in place.....per lb.						08 00	08 00
Drift-bolts and straps in place.....do.						08 00	08 00
Spikes in place.....do.						12 00	15 00
Stone in place.....per cord.						10 00	10 00
Cedar bark or brush in place.....do.						15 00	4 00
Shingle shavings in place.....do.							
Dredging.....per cub. yd.	\$0 28	\$0 27 1/2	\$0 29	\$0 27	\$0 28		
Total						7,700 64	8,167 58

* Award recommended.

Contract with Dewar & Wing, of Ludington, Mich., dated November 20, 1882, expiring June 30, 1883 (extended to August 10, 1883), for pier construction.

Contract with Green Bay Dredge and Pile-Driver Company, of Green Bay, Wis., for dredging, at 23 cents per cubic yard, of material dredged and removed, as measured in the dump-scows.

Tabulated statement of commercial statistics, Manistee Harbor, Michigan, from July 1, 1882, to June 30, 1883.

Year ending—	Vessels entered and cleared.	Revenue collected.
June 30, 1883.....	3, 323	\$2, 686 02

I I 5.

IMPROVEMENT OF LUDINGTON HARBOR, MICHIGAN.

By day labor and purchased material the repairs to the outer 25 feet of the south pier (damaged by collision May 23, 1882) were completed. These repairs consisted in building and sinking an auxiliary crib 50 by 25 by 6 feet, and securing the same to the submerged portion of the damaged crib, after first having cut down and removed all broken and damaged timbers and iron from the old work.

One hundred linear feet of superstructure was then placed over the damaged crib sunk in 1881 and the crib next inside, sunk in 1880.

Two intervals at outer end of south pier were repaired and secured by complete filling of cedar bark, weighted down with stone, and the outer end of pier protected by a timber pier-head. Fifty cords of stone have been contracted for to complete filling at outer end of south pier; after it is delivered the new superstructure will be decked over and completed.

A small amount of dredging by the United States dredge, for the temporary relief of the harbor, was done in the month of September. One cut was made in the axis of the channel, and 4,020 cubic yards of material removed, which resulted in deepening the channel to 13 feet.

The dredge was employed from the 1st to the 16th of September, but was frequently delayed by bad weather.

Minor details of repairs to stop sand-leaks through the pile revetment, south side, were made.

Under the appropriation of August 2, 1882, sealed proposals were invited for the extension of the south pier, by a 50 by 30 by 18½ foot crib, to be placed on a pile foundation; also for dredging in the channel.

Mr. Tully H. Smith, of Milwaukee, Wis., was the lowest bidder, and is now under contract to dredge as much as may be necessary to place the channel in good condition.

Owing to the unusually high water prevailing in Lake Michigan this season, Mr. Smith's contract has been extended. He is, however, expected to complete dredging in time to accommodate the fall and winter navigation.

Mr. Smith was also the lowest bidder for pier extension, but owing to high contract rates for timber, work, and stone, it was found that the funds on hand after making necessary repairs would not be sufficient to build and sink one crib. Mr. Smith's contract for pier extension was not therefore approved by the Chief of Engineers.

1816 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Further operations for the improvement of this harbor, under the approved project, will consist in pier extension and in dredging in the channel, as may be found necessary, and it is estimated that \$40,000 can be expended to advantage for this purpose during the fiscal year ending June 30, 1885.

It is respectfully recommended that this amount be appropriated.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich. The nearest light-house is Grand An Sable. A light is shown near the end of the south pier.

Original estimated cost of work, 1866, amended 1879.....	\$213, 787 07
Whole amount appropriated from 1866 to 1883, inclusive	226, 185 00
Amount expended.....	220, 101 95

The estimated amount required for the entire and permanent completion of the work, in accordance with the project adopted, is indeterminate.

Money statement.

July 1, 1882, amount available.....	\$1, 263 84
Amount appropriated by act passed August 2, 1882.....	12, 000 00
	<hr/> 13, 263 84
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$6, 301 56
July 1, 1883, outstanding liabilities.....	879 23
	<hr/> 7, 180 79
July 1, 1883, amount available.....	6, 083 05
Amount that can be profitably expended in fiscal year ending June 30, 1885.	<hr/> 40, 000 00

Abstract of bids received and opened October 28, 1882, by Maj. D. P. Heap, Corps of Engineers, for improving harbor at Ludington, Mich.

Materials.	1. Carlin, Stickney & Cran- East Saginaw, Mich.	2. Green's Dredging Com- pany, O. R. Green, presi- dent, Chicago, Ill.	3. Tully H. Smith, Milwan- kee, Wis.	4. Dewar & Wing, Luding- ton, Mich.	5. George Talbot, Buffalo, N. Y.
Piles, foundation, in place..... per linear foot.....			\$1 75	\$2 00	\$1 50
Piles, sheet, in place..... do.....			23	50	25
White oak in place, B. M..... per M feet.....			50 00	50 00	50 00
Hemlock timber in place, B. M..... do.....			80 00	23 00	25 00
Pine timber in place, B. M..... do.....			36 00	23 00	26 00
Pine plank in place, B. M..... do.....			25 00	38 00	30 00
Screw and washer bolts in place..... per pound.....			06	08	10
Drift-bolts and straps in place..... do.....			05	05	08
Spikes in place..... do.....			06	08	08
Stone in place..... per cord.....			15 00	15 00	15 00
Cedar bark or brush in place..... do.....			9 00	5 00	8 00
Shingle shavings in place..... do.....			7 00	8 00	4 00
Dredging..... per cubic yard.....	\$0 30	\$0 29	28	.....	70
Total.....	30	29	7, 376 36	7, 975 00	8, 086 44

Contract with Tully H. Smith, dated November 23, 1882, expiring June 30, 1883 (extended to September 1, 1883, for dredging).

Tabulated statement of commercial statistics, Ludington Harbor, Michigan, from July 1, 1882, to June 30, 1883.

Year ending—	Vessels entered and cleared.	Revenue collected.
June 30, 1883.....	2, 188	\$1, 471 82

I I 6.

IMPROVEMENT OF PENTWATER HARBOR, MICHIGAN.

Operations for the improvement of this harbor, under the appropriation of August 2, 1882, were commenced early in the month of October.

By day labor and purchased material the modified superstructure was placed over the 50 by 30 foot crib sunk in extension to the north pier in 1881. The outer end of the crib next inside, damaged by collision while occupying the position of end crib, was cut down and repaired for a length of 20 feet, and the new superstructure continued back to a joint with the old work on this crib.

The filling of the pile revetment at the shore-line of south pier having settled badly, and an extensive leak of sand into the channel resulting, the work at this point for the length of 50 feet was overhauled and refilled with edgings, cedar bark, and stone.

Operations were suspended on the last day of November, 1882.

During the month of September, 1882, proposals were invited for pier construction at the outer end of north pier for dredging in the channel.

Mr. Tully H. Smith, of Milwaukee, Wis., was the lowest bidder for pier work, and a contract was signed with him for the extension of the north pier, by a 50-foot crib to be sunk on a pile foundation. This contract, however, was not perfected and closed on account of the large amount of funds needed for repairs and dredging.

The contract for dredging was awarded to Messrs. Squier & White, of Grand Haven, Mich., and it is expected that it will be completed and closed early in the month of August, 1883.

Further operations for the improvement of this harbor will, under the approved project, consist in pier extension and dredging. It is estimated that \$40,000 can be profitably expended for this purpose during the fiscal year ending June 30, 1885, and it is respectfully recommended that this amount be appropriated.

This work is located in the Michigan collection district, Michigan. The nearest light-house is at Little Point Sable; a light is shown near head of south pier, and the nearest port of entry is Grand Haven, Mich.

Original estimated cost, 1866, amended, 1873.....	\$192, 020 00
Whole amount appropriated from 1866 to 1883, inclusive.....	192, 520 00
Amount expended.....	186, 969 53

The estimated amount for the entire and permanent completion of the work in accordance with the project adopted is indeterminate.

Money statement.

July 1, 1882, amount available	\$50 23
Amount appropriated by act passed August 2, 1882.....	10, 000 00
	10, 050 23
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	3, 199 76
July 1, 1883, amount available	6, 850 47
Amount that can be profitably expended in fiscal year ending June 30, 1885.	40, 000 00

1818 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of bids received and opened October 28, 1882, by Maj. D. P. Hoap, Corps of Engineers, for improving harbor at Pentwater, Mich.

Materials.	*1. Squier & White, Grand Haven, Mich.	2. Carlin Stinson & Cram, East Saginaw, Mich.	3. Green's Dredging Company, O. B. Green, president, Chicago, Ill.	4. Edwin Nickerson, Pentwater, Mich.	*5. Tully H. Smith, Milwaukee, Wis.	6. Dewar & Wing, Ludington, Mich.	7. George Talbot, Buffalo, N. Y.
Piles, foundation, in place, per linear foot.....				\$1 90	\$1 75	\$2 00	\$2 50
Piles, sheet, in place, per linear foot.....				1 00	22	50	50
White oak, in place, B. M., per M feet.....				50 00	50 00	50 00	50 00
Hemlock timber, in place, B. M., per M feet.....				30 00	30 00	30 00	35 00
Pine timber, in place, B. M., per M feet.....				32 00	30 00	40 00	40 00
Screw and washer bolts, in place, per pound.....				10	06	08	08
Drift bolts and straps, in place, per pound.....				05	05	05	05
Spikes, in place, per pound.....				07	06	08	08
Stone, in place, per cord.....				12 00	15 00	15 00	15 00
Cedar bark or brush, in place, per cord.....				6 00	9 00	5 00	8 00
Shingle shavings, in place, per cord.....				6 00	7 00	3 00	4 00
Dredging, per cubic yard..	\$0 23	\$0 30	\$0 28		29		70
Total.....				8,772 32	7,876 36	8,156 02	8,471 77

* Award recommended.

Contract with Squier & White, of Grand Haven, Mich., dated November 25, 1882, expiring June 30, 1883 (extended to September 15, 1883), for dredging, at 23 cents per cubic yard of material dredged and removed, as measured in the dump-scoops.

Tabular statement of commercial statistics, Pentwater Harbor, Michigan, from July 1, 1882, to June 30, 1883.

Year ending—	Vessels entered and cleared.	Revenue collected.
June 30, 1883.....	440	\$261 03

II 7.

IMPROVEMENT OF WHITE RIVER HARBOR, MICHIGAN.

Under the appropriation of \$12,000, provided by an act of Congress passed August 2, 1882, proposals were invited, under date of September 18, for building and placing one crib on pile foundation in extension of the south pier.

Bids were opened October 28.

Messrs. Dewar & Wing, of Ludington, Mich., were the lowest bidders, but the closing of the contract was deferred, and finally indefinitely postponed, because it became apparent that the amount of money necessary for placing the superstructure upon the three outer cribs of the south pier which remained unfinished would be so great that the price bid for the proposed new crib could not be met.

On August 31 proposals were invited for furnishing materials for superstructure over the unfinished cribs, which resulted in awards as follows:

For furnishing pine timber: Thomas R. Lyon, agent, of Ludington, Mich.

For furnishing iron: Messrs. Keepers & Riddell, of Milwaukee, Wis.

For furnishing stone: Michigan Barge Company, of Grand Haven, Mich.

For furnishing cedar bark: Messrs. J. B. Smith & Co., of Chicago, Ill.

An inspector was placed in charge on the 9th of October; timber arrived on the 28th, and a small force of men began framing.

In the mean time, owing to the heavy weather that prevailed, the exposed cribs, and more especially the middle one of the three, were damaged to so great an extent that it became necessary to change the plan of leveling them up to receive the superstructure. The weather grew cold rapidly, and the prospects for accomplishing anything in a satisfactory manner were so poor that the inspector was directed to level up the outer crib to 1 foot above water, ballast the outer pockets, and deck over. Work for the season was suspended on November 10.

In the spring much trouble was experienced by vessels drawing 9 feet of water in getting in and out, and propellers engaged in the local trade were obliged to dredge their way with their wheels during the early part of the season.

The middle crib received still further damage during the winter and spring, and it was decided to widen the work to 30 feet, this being the width of the outer crib, by driving a row of close piling in a line prolonging the south wall of the outer crib, cut the piles off at low-water mark, secure with walling and binder, and build up the south wall of the superstructure upon the piles, the interval between the piles and the broken south wall of the crib to be filled with cedar bark well ballasted with stone.

Work was resumed May 21, 1883; since then the inner crib has been leveled up. Piles have been driven for the foundation of the south wall of the second crib, and the outer crib has been cut down to the plane established for the new superstructure.

All work is being done by day labor, and the piles driven were placed by the United States pile-driver.

The condition of the north pier and revetment is so bad that the whole structure is of little practical value. The filling is gone in much of the pier, in other portions badly shaken up and settled out of place; the superstructure and upper ends of piles supporting it are much decayed and should be replaced from the water-line. The stone has been removed from the revetment until there is hardly any left. The south revetment is not much better than the north and should receive about the same treatment as is recommended for the north pier and revetment.

Until the piers and revetments are made sand-tight there must be trouble to vessels from the shoaling caused by sand which finds its way through the work, the chief trouble at this harbor being the shoal water between the piers on both sides of the shore line where it makes the piers.

The money now available will be used in completing the superstructure of the three cribs before mentioned and in repairs to other portions of the work. The present depth of water is 9 feet.

For the fiscal year ending June 30, 1885, it is estimated that \$50,000 can be expended to advantage. It is respectfully recommended that this amount be appropriated to be expended in renewing the revetments on both sides of the channel above the water line, and the superstructure of both piers also, where necessary. The balance, should any remain, can be profitably used in extending the south pier.

1820 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

The work is in the Michigan collection district, Michigan, and is situated at the White River light. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work 1866, amended 1873	\$220,445 56
Whole amount appropriated from 1866 to 1883, inclusive	227,550 00
Amount expended	219,900 84

The estimated amount required for the entire and permanent completion of the improvement in accordance with the plan adopted is indeterminate.

Money statement.

July 1, 1882, amount available	\$105 55
Amount appropriated by act passed August 2, 1882	12,000 00
	<hr/> 12,105 55
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$3,906 87
July 1, 1883, outstanding liabilities	549 52
	<hr/> 4,456 39
July 1, 1883, amount available	7,649 16
Amount that can be profitably expended in fiscal year ending June 30, 1885	<hr/> <hr/> 50,000 00

Tabulated statement of commercial statistics, White River Harbor, Michigan, from July 1, 1882, to June 30, 1883.

Year ending—	Vessels entered and cleared.	Revenue collected.
June 30, 1883	1,918	\$1,410 18

I I 8.

IMPROVEMENT OF MUSKEGON HARBOR, MICHIGAN.

On the 14th of July, 1882, Mr. J. W. Dennis, contractor, completed his contract, which provided for the building and sinking, upon a stone foundation in a prepared trench, three cribs, in detached sections, north of the north pier, the object being to widen the entrance of the harbor to 300 feet. The cribs were raised to a height of 2½ feet above water level and decked over.

All work was suspended July 31, through lack of funds.

Under the appropriation made by an act of Congress passed August 2, 1882, work was resumed, the project being:

1. To repair a break in the end of the south pier, caused by a colliding vessel.

2. To replace the superstructure of a 32-foot square crib 300 feet east from the outer end of south pier.

3. To replace the superstructure of 220 linear feet of pile-pier, 20 feet wide, next east from the last named; and,

4. To refill 60 linear feet of pile revetment, 14 feet wide, next east.

Proposals for furnishing materials were invited August 31, resulting in the following awards:

1. Furnishing pine timber, to Messrs. McGraft & Montgomery, of Muskegon, Mich.
2. Furnishing cedar bark, to Messrs. J. B. Smith & Co., of Chicago, Ill.
3. Furnishing stone, to Michigan Barge Company, of Grand Haven, Mich.
4. Furnishing iron, to Messrs. Keepers & Riddell, of Milwaukee, Wis.

The repairs were pushed so far as to cover the work at the end of the pier, and 115 feet of the 20-foot pile-pier nearest shore was nearly re-

superstructured, when, on the 6th of December, it became necessary to suspend operations outside.

October 28, bids for building and placing three or four cribs, 50 by 30 by 18½ feet, with superstructure 2 feet high, on pile foundation, in extension of the detached north pier, were opened, and the contract awarded to Messrs. Gillen & Kirby, of Grand Haven, Mich., who were notified that but three cribs could be paid for from the funds available. The terms of this contract provided that the work should be completed on or before June 30, 1883.

January 10, 1883, the contractors gave notice that they were ready to commence work, and the inspector was placed on duty. Timber did not arrive, owing to heavy snows in the woods, and the commencement of the work was delayed until February 17.

The three cribs were finished, to include the sixteenth course, May 5, when it was found necessary to provide for a larger balance of funds than would remain after paying for the three cribs completed and sunk, in order to meet the expense of the repair work, which the heavy weather of the fall and spring months had increased by further damaging the old work.

A modification of the contract was accordingly agreed upon and duly filed, whereby Messrs. Gillen & Kirby delivered one crib, built to include the sixteenth course, receiving therefor contract prices for the timber and iron used in its construction, also the piles, twenty-seven in number, for its foundation, at 17 cents per linear foot.

The two cribs are completed ready for sinking. The dredging and piling are also done, and the contractors would have had the cribs in position two weeks ago had the weather permitted.

The inspector has been fully occupied with the crib-building up to date, but day labor work will be taken up immediately, and the repairs upon the south pier pushed to completion, or as nearly so as the funds available will allow.

Considering the two new cribs as in place, the north pier is only 25 feet shorter than the south.

It is recommended, in view of the fact that the southwest seas scour along the channel face of the detached section of the north pier so as to leave from 30 to 40 feet of water, that the funds available under the next appropriation be applied to the extension of the south pier. A further reason for such application of funds is that vessels need a lee in making this harbor in heavy southwest weather, in order that they may come upon their course without colliding with the piers.

It is further recommended that the south pier be kept 300 feet the longer as the piers are advanced lakeward.

For the continuation of the approved project, superstructuring the detached north pier, and for repairs, it is estimated that \$100,000 can be expended to advantage during the fiscal year ending June 30, 1885, and it is respectfully recommended that this amount be appropriated to be expended as already indicated. The depth of water at present is 14 feet.

This work is located in the Michigan collection district, Michigan. It is situated at the Muskegon light. The nearest port of entry is Grand Haven, Mich.

The original estimated cost of work 1866, amended 1879	\$168,901 75
Whole amount appropriated from 1866 to 1883, inclusive	201,500 00
Amount expended	193,015 82

The estimated amount required for the entire and permanent completion of the improvement in accordance with the project adopted is indeterminate.

1822 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Money statement.

July 1, 1882, amount available.....	\$6,891 13
Amount appropriated by act passed August 2, 1882.....	25,000 00
	<hr/> 31,891 13
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$13,157 27
July 1, 1883, outstanding liabilities	10,249 68
	<hr/> 23,406 95
July 1, 1883, amount available.....	8,484 18
Amount that can be profitably expended in fiscal year ending June 30, 1885.	<hr/> 100,000 00

Abstract of bids received and opened October 28, 1882, by Maj. D. P. Heap, Corps of Engineers, for improving harbor at Muskegon, Mich.

Materials.	1. Uriah Calbert, Michigan City.	*2. Gillen & Kirby, Grand Haven, Mich.	3. Dewar & Wing, Ludington, Mich.	4. George Talbot, Buffalo, N. Y.
Piles, foundation, in place..... per linear foot..	\$1 25	\$0 90	\$2 00	\$1 50
Piles, sheet, white oak, in place..... do.....	30	25	50	40
Timber, hemlock, in place, B. M..... per M. foot..	26 00	25 00	30 00	30 00
Timber, pine, in place, B. M..... do.....	30 00	30 00	40 00	35 00
Timber, white oak, in place, B. M..... do.....	45 00	40 30	50 00	50 00
Screw and washer bolts, in place..... per pound.....	05	10	08	08
Drift bolts and straps, in place..... do.....	05	04	05	08
Spike, in place..... do.....	05	05	08	08
Stone, in place..... per cord.....	12 00	13 00	15 00	14 00
Cedar bark, in place..... do.....	6 00	3 00	10 00	8 00
Dredging..... per cubic yard.....	00	40		1 00
Total.....	6,586 85	6,344 35	8,245 04	7,315 25

* Award recommended.

Contract with Gillen & Kirby, dated November 24, 1882, expiring June 30, 1883 (extended to July 31, 1883), for pier-construction and dredging.

Tabulated statement of commercial statistics, Muskegon Harbor, Michigan, from July 1, 1882, to June 30, 1883.

Year ending—	Vessels entered and cleared.	Revenue collected.
June 30, 1883.....	6,900	\$4,328 56

I I 9.

IMPROVEMENT OF GRAND HAVEN HARBOR, MICHIGAN.

Mr. J. W. Dennis, of Buffalo, N. Y., finished the work under his contract on the 30th of September, 1882. Six cribs were placed in extension of the south pier under this contract.

The alignment and general appearance of this piece of work is excellent, and its effect upon the water outside has been very marked in the increase and uniformity of depth over what had been, until 1882, very questionable ground.

It was found that the scour under the channel-face of the work was

so great as to endanger it. A riprap was placed along this (channel) face, which has done its work satisfactorily.

The driving of sheet-piling on the lake or south side was accomplished with great difficulty, owing to the length of the timber exposed to the shock of the hammer and the frequent encountering of obstacles below the surface of the sand at the bottom of the lake.

There has been no perceptible scour under the lake or south side of the work.

Under the appropriation by act of Congress passed August 2, 1882, proposals were invited for building and placing upon pile foundation two or three cribs, 50 by 30 by 18½ feet, with superstructure two courses high, in extension of the south pier, which resulted in the award of a contract to Messrs. Gillen & Kirby, of Grand Haven, Mich., the number of cribs to be placed being limited to two, by reason of the necessity for extensive repairs in the shape of replacing the superstructure over 700 linear feet of crib-work and pile-pier, and the substitution of new superstructure throughout nearly one entire side of the whole length of the work specified.

Work under this contract was begun February 17, 1883, and would have been completed in the early part of June but for the rough weather.

The cribs are sunk in perfect line and level, and the superstructure nearly completed over both. These cribs are riprapped on both sides to the extent of only 10 cords of fair-sized stone to each side of each crib; this in place of sheet-piling used last year on the lake side of the work.

The water in Grand River has been unusually high and the current very swift for the past month, yet there appears to have been no scour along the channel-face of the new work worth mentioning.

The Light-House Department has moved the pier-light and fog-signals out upon the new work of last year, so that the pier-light stands within 125 feet of the present pierhead.

By day labor work has been carried on as rapidly as the boisterous weather would permit.

The superstructure of 300 linear feet of pile-pier, at and near the shore-line, south side, has been torn away; a part of the pile substructure renewed, new oak waling and binder have been placed at the water-line and the first course of ties and side walls are in place nearly the entire length of the work.

Extensive repairs in the way of overhauling and refilling have been put upon the south revetment next adjoining the pile-pier above mentioned and extending over 1,190 linear feet of work.

The north revetment has been thoroughly overhauled and refilled for a distance of 75 linear feet at and near the shore-line; also at other places which require attention, which places collectively represent 280 linear feet of work.

Aprons of oak timber, edge-bolted, sixteen in number, have been fastened in intervals between piles and cuts where the filling was exposed to the seas.

Some repairs have been put upon the sand-fences upon dunes opposite the city, and 1,960 linear feet of catch-sand fences have been built just above town, and other sections opposite, making the entire length of fence built 2,580 feet.

The system of sand-fences in use here now for over two years is very satisfactory in its workings, and demonstrates that these drifting sands can be controlled.

The shoalest sounding outside, as shown by soundings taken late in the fall of 1882, was 14 feet. This was on a line prolonging the south

pier and at a point about 350 feet out from the pier-head. North of this line the water ranged from 16 to 19 feet in depth, with a width of way nearly equal to the distance between the piers, viz, 400 feet, the water deepening to the northward.

There was no trouble or disaster of any kind at this harbor during the fall or season of 1882 resulting from shoal water.

The conditions at this time are considerably changed from those of last fall.

The water is now best outside, opposite mid-channel, and shoals to the northward, there being quite a uniform depth of 18 feet on the mid-channel course straight out.

Continuous storms from southwest or northwest are liable to affect the sands upon the bar during times of slack water in the river until the piers shall have been so extended as to cut through the bar, which extension is contemplated under the approved project.

The work upon renewal of old superstructure will be continued, and probably completed with the funds now on hand, and it is recommended that the next money appropriated be applied to the extension of the south pier. This for the reason that observation during the past six years shows that when the south pier is so much longer than the north pier as to cover the latter during southwest storms there is a channel available for deep-draught vessels straight out in a line just north of the line of the south pier, while shoaler water is found to the northward.

It was thought at one time that by extending the north pier well beyond the south the discharge of Grand River would act with the littoral current of Lake Michigan and hold its force well out in the lake. Practice, however, demonstrated that this was a mistake, for the conflict between the river current and the littoral current of Lake Michigan, which is always very strong to the north under heavy southwest weather, caused the sand and other material brought down by the river waters to settle just outside the mouth of the harbor, forming a dangerous bar.

For continuing pier-extension under the approved project \$150,000 can be expended to advantage during the fiscal year ending June 30, 1885, and it is respectfully recommended that this amount be appropriated.

This harbor is an important one, being the transfer point of a trunk line of railroad, with Milwaukee connections, open all the year round. It is sought as a harbor of refuge by all classes of vessels plying the great lakes, and requires rapid extension of its piers to make it a secure and safe harbor at all seasons.

This work is located in the collection district of Michigan. It is situated at the Grand Haven lights. Grand Haven is a port of entry.

Original estimated cost of work in 1866	\$352, 770 47
Whole amount appropriated from 1866 to 1883, inclusive.....	441, 866 15
Amount expended	426, 967 40

Money statement.

July 1, 1882, amount available	\$41, 779 18
Amount appropriated by act passed August 2, 1882	40, 000 00
	<hr/> 81, 779 18
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$62, 455 29
July 1, 1883, outstanding liabilities	4, 445 14
	<hr/> 66, 900 43
July 1, 1883, amount available	14, 878 75
	<hr/>
Amount (estimated) required for completion of existing project	260, 000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	150, 000 00

Abstract of bids received and opened October 28, 1882, by Maj. D. P. Heap, Corps of Engineers, for improving harbor at Grand Haven, Mich.

Materials.	1. T. Stewart White, Grand Haven, Mich.	2. * Gillen & Kirby, Grand Haven, Mich.	3. Castle Sutherland, East Saginaw, Mich.	4. Tully H. Smith, Mil- waukee, Wis.	5. Dewar & Wing, Ind- ington, Mich.	6. George Talbot, Buf- falo, N. Y.
Piles, foundation, in place...per lin. ft..	\$1 25	\$0 30	\$1 00	\$1 40	\$2 00	\$1 50
Piles, sheet, white oak, in place...do....	30	25	20	20	50	40
White oak timber, in place, B. M....per M feet.....	45 00	28 00	40 00	40 00	50 00	50 00
Hemlock timber, in place, B. M. pr. M ft..	25 00	24 00	25 00	24 50	30 00	28 00
Fine timber, in place, B. M. pr. M ft..	30 00	29 00	30 00	32 00	40 00	35 00
Screw and washer bolts, in place pr. lb..	05	10	08	06	08	08
Drift-bolts and straps, in place...do....	05	04½	08	04	05	06
Spikes, in place.....do.....	05	05	08	05	08	06
Stone, in place.....per cord..	11 50	13 00	12 00	12 00	15 00	14 00
Cedar bark, in place.....do....	6 00	3 00	5 00	5 00	10 00	6 00
Dredging.....per cubic yard..	60	40	30	75	.....	90
Total.....	6,409 27	6,246 30	6,507 00	6,266 72	8,245 64	7,715 26

* Award recommended.

Contract with Gillen & Kirby, dated November 24, 1882, expiring June 30, 1883 (extended to July 31, 1883), for pier construction and dredging.

Tabulated statement of commercial statistics Grand Haven Harbor, Michigan, from July 1, 1882, to June 30, 1883.

Year ending—	Vessels entered and cleared.	Revenue collected.
June 30, 1883.....	2,762	\$4,194 19

III.

IMPROVEMENT OF GRAND RIVER, BELOW GRAND RAPIDS, MICHIGAN.

Under contract with Messrs. Squier & White, of Grand Haven, Mich., dredging was begun November 16, 1882, where work terminated 1881, viz, at a point 1,950 feet above the Lake Shore and Michigan Southern Railroad Bridge, upon what is known as "Flat Rock," and a single cut about 20 feet wide at the bottom and 955 feet long had been made up to December 8, when the intensely cold weather put a stop to further operations.

The material removed consisted of sand, heavy gravel, and boulders of various sizes, the last named yielding about 25 per cent. of the mass of material handled.

The total amount removed up to December 8 was 2,232.14 cubic yards.

Work was resumed April 17, continuing the cut from the point where work ceased in the fall. This cut was completed and a second cut adjoining it on the south was also completed, its length being 1,213 feet.

The dredge was then removed to attend to some other work and for repairs, and upon its return work was resumed at a point 1,870 feet

1826 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

below Robar Island, continuing the cut of 1881 490 feet, when the water in the river became so high as to render further work for the time impossible.

The total amount of dredging classed as bowlders for the year was 6,171.89 cubic yards.

The total amount of dredging classed as clay for the year was 1,035 cubic yards.

The work will be continued until the funds available are exhausted, and it is thought that further appropriations for temporary relief will not be necessary for some time at least.

No appropriation is asked, therefore, for the fiscal year ending June 30, 1885.

Original estimated cost of dredging, 1881.....	\$25,000 00
Whole amount appropriated, 1881 to 1883.....	25,000 00
Amount expended.....	14,534 73

Money statement.

July 1, 1882, amount available.....	\$2,363 30
Amount appropriated by act passed August 2, 1882.....	15,000 00
	17,363 30
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$5,881 54
July 1, 1883, outstanding liabilities.....	1,016 54
	6,898 08
July 1, 1883, amount available.....	10,465 22

Abstract of bids received and opened October 28, 1882, by Maj. D. P. Hoap, Corps of Engineers, for dredging Grand River, below Grand Rapids, Mich.

No.	Bidders' names and residences.	Dredging and removing—		
		Gravel.	Bowlders.	Clay.
		<i>Per cu. yd.</i>	<i>Per cu. yd.</i>	<i>Per cu. yd.</i>
*1	Squier & White, Grand Haven, Mich.....	\$0 40	\$0 80	\$0 50
2	Carkin, Stickney & Cram, East Saginaw, Mich.....	90	1 25	90
3	Green's Dredging Company, O. B. Green, president, Chicago, Ill.....	92½	1 29½	92½
4	Castle Sutherland, East Saginaw, Mich.....	60	1 25	60

*Award recommended.

Contract with Squier & White, of Grand Haven, Mich., dated November 13, 1882, expiring August 31, 1883. All measurements to be made on lighters.

I I II.

IMPROVEMENT OF BLACK LAKE HARBOR, MICHIGAN.

No work was done upon this harbor in the fall of 1882.

November 18, 1882, proposals for building one crib 50 by 30 by 18½ feet upon pile foundation in extension of the south pier were opened, the contract being awarded to Messrs. Dewar & Wing, of Ludington, Mich.

Before work was begun it became necessary to make repairs to the north pier.

The heavy northwest storms during April and May carried away 50 feet of the superstructure of this work, which is very much decayed, to from 2 feet to 4 feet below water.

The whole superstructure of the north pier from this break, shoreward a distance of over 400 feet, was discovered, upon examination, to be so far decayed as to render its replacement immediately necessary.

A modification of the terms of the contract with Messrs. Dewar & Wing was made in order that the funds intended for the crib proposed might be made available for repairing this north pier.

By the terms of the modification Messrs. Dewar & Wing are to be relieved from building and sinking the crib, but are to furnish as follows:

Twenty-seven hard-wood (oak or rock-elm) piles, each 35 feet long, at 20 cents per running foot.

Twenty-eight sheet piles (white oak), 32 feet long, at \$50 per thousand feet, B. M.

Fifty thousand feet, B. M., hemlock timber, 12 by 12 inches cross-section, at \$20 per thousand feet, B. M.

Six hundred and seventy-two feet oak timber, at \$50 per thousand feet, B. M.

One hundred and eighty cords of stone, at \$13 per cord.

During last fall the tools were removed to the division store-house at Grand Haven, the United States buildings being placed in charge of the light-keeper at the harbor.

An inspector was stationed at this harbor on the 28th of June, and work upon resuperstructuring of the north pier will be begun at once and continued so far as the funds available will carry them.

Soundings lately taken show an average of over 9 feet in mid-channel at the present stage of water. This would give the shoalest sounding at 7.7 feet below the level of mean low water.

The trade is almost entirely local, and is carried on by vessels of light draught.

It is deemed proper to recommend that only such money be expended during the fiscal year ending June 30, 1885, as may be required for repairs to existing works, such repairs embracing the resuperstructuring of 350 feet of the south pier, the rebuilding of the superstructure of the two outer cribs of the south pier, which have settled badly out of line and torn apart, and leveling up the north pier head with the necessary ballast and decking.

The sum of \$20,000 will be required for all this work, allowing for a small amount of dredging which may be necessary, and it is respectfully recommended that this amount be appropriated.

The work is located in the Michigan collection district, Michigan, at the Holland light. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work, 1866	\$106, 238 04
Whole amount appropriated from 1866 to 1883, inclusive	239, 615 31
Amount expended	230, 706 36

The amount estimated to be required for the entire and permanent completion of the improvement in accordance with the plan adopted is indeterminate.

Money statement.

July 1, 1882, amount available	\$136 75
Amount appropriated by act passed August 2, 1882	10, 000 00
	<hr/> 10, 136 75
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	1, 227 80
	<hr/> 8, 908 95
July 1, 1883, amount available	8, 908 95
Amount that can be profitably expended in fiscal year ending June 30, 1885.	<hr/> <hr/> 20, 000 00

1828 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of bids received and opened November 18, 1882, by Maj. D. P. Heap, Corps of Engineers, for improving harbor at Black Lake, Mich.

Materials.		1. George Talbot, Buffalo, N. Y.	2. Dewar & Wing, Ludington, Mich.
Piles, foundation, in place.....	per linear foot..	\$2 00	\$1 50
Piles, sheet, in place.....	do.....	50	40
White-oak timber in place, B. M.....	per M feet..	60 00	50 00
Hemlock timber in place, B. M.....	do.....	35 00	25 00
Pine timber in place, B. M.....	do.....	40 00	25 00
Screw and washer bolts in place.....	per pound..	10	8
Drift-bolts and straps in place.....	do.....	08	08
Spikes in place.....	do.....	08	08
Stone in place.....	per cord..	15 00	13 00
Cedar bark or brush in place.....	do.....	15 00	6 00
Dredging.....	per cubic yard..	2 00	3
Total		9,586 16	*7,388 2

* Award recommended.

Contract with Dewar & Wing, dated December 6, 1882, expiring June 30, 1883 (extended to August 10, 1883), for pier construction, and dredging as measured in the cut.

Tabulated statement of commercial statistics Black Lake Harbor, Michigan, from July 1, 1882, to June 30, 1883.

Year ending—	Vessels entered and cleared.	Revenue collected.
June 30, 1883.....	178	\$218 5

II 12.

IMPROVEMENT OF SAUGATUCK HARBOR, MICHIGAN.

No work was done at this harbor during the latter part of the season of 1882.

Twenty-four cords of stone were provided against a possible break in the filling of the south pier near the shore line. This break occurred early in March, 1883, and was repaired in June, some minor overhauling and refilling being done at the same time.

Stone used.....	cords..	24
Cedar bark.....	do...	30

The condition of this harbor is very bad. An examination recently made shows a bar just outside the piers upon which but a trifle over 8 feet of water is found. A middle ground has formed along mid-channel which extends nearly to the lower end of the north revetment at the bend in the river, from 200 feet inside the mouth, upon which the water ranges from 7 feet to 9.5 feet in depth.

This is a deposit brought down from the immense sand dunes and the area north and west of the river, at and just above the bend.

The filling throughout the south revetment and pile pier needs overhauling and replacing. This will probably be done with funds now on

hand, though little practical benefit will result, unless some money is expended in preventing the drift of the sands upon the area at and above the bend, where they are rapidly filling in and encroaching upon the river, only to be cut away by the strong current and distributed along the "middle ground" and on the bar outside.

The entrance is dangerous for light-draught vessels, even in still weather. The shore line south is only 170 feet from the pier-head, with very shoal water over the area just south of the pier, and in fact extending lakeward beyond this area.

The shipping of the port is local, and the traffic is confined to the product of three lumber mills, large quantities of fruit, and a considerable amount of general produce.

In order to carry out the views of the Department, as expressed in letter of Chief Engineers to Major Heap, under date of October 14, 1882, to wit:

In carrying on operations at this harbor, you will be governed by the suggestion contained in the closing paragraph of the report (Report of Board of Engineers on Saugatuck Harbor, Mich., dated Grand Rapids, Mich., June 28, 1882)—whether the present depth is not sufficient for the present and prospective commerce, and whether the appropriation should not be applied merely to maintaining the existing condition of the improvement,

I shall, as soon as she can be spared, send the Government dredge to this harbor, in order to open a passage through the bar exterior to the piers. This will only afford temporary relief. The same state of affairs will undoubtedly exist next season, only in a more aggravated form; for as the shore line advances, the greater will be the tendency to shoaling about the ends of the piers. Eventually if dredging alone is resorted to, in order to keep the channel open, this method will be found too expensive, and the harbor will either have to be given up or the piers extended.

As the piers and revetments will necessarily require more or less repairs, as shown by the break this year in the south pier, and as more or less dredging will be required on the bar outside and between the piers, I would respectfully recommend that an appropriation of \$12,000 be made for the fiscal year ending June 30, 1885, to meet such contingencies.

This work is located in Michigan collection district, Michigan, and is situated at the Kalamazoo light. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work, 1866, modified, 1869	\$86,398 56
Whole amount appropriated 1868 to 1883, inclusive	123,439 00
Amount expended	116,390 53

The amount estimated to be required for the entire and permanent completion of the improvement in accordance with the plan adopted is indeterminate.

Money statement.

July 1, 1882, amount available	\$161 25
Amount appropriated by act passed August 2, 1882	8,000 00
	<hr/> 8,161 25
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$1,005 28
July 1, 1883, outstanding liabilities	107 50
	<hr/> 1,112 78
July 1, 1883, amount available	7,048 47
	<hr/> 12,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	

1830 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Tabulated statement of commercial statistics Saugatuck Harbor, Michigan, from July 1, 1882, to June 30, 1883.

Year ending—	Vessels entered and cleared.	Revenue collected.
June 30, 1883	297	\$489 50

II 13.

IMPROVEMENT OF SOUTH HAVEN HARBOR, MICHIGAN.

During the latter part of the season of 1882 construction and repair work was carried on by day labor, the materials being purchased in open market.

On the south side floors were built and sunk in four pockets of the outer crib, and this and the second crib, together with the intervals, were reballasted.

One hundred and fifty feet of the south revetment was overhauled and refilled with cedar bark and reballasted.

The inside portion of the south plank beam wall, which had been left unstayed, was tied back with iron rods passing through substantial anchors set in the ground.

On the north side 85 linear feet of plank beam revetment was built on the lake side of and within the pile revetment near the shore line. The filling was removed from 482 linear feet of this north revetment and replaced with cedar bark and reballasted.

Five hundred and ninety-two linear feet of sand-fence was built on the north side, covering the channel against drift, and the most advanced and exposed fence was protected against the wash of the seas by a breakwater or guard constructed of heavy slabs cut to 6 feet lengths and set in the sand 3 feet deep in a double row, the flat faces being placed together and covering joints.

Work was suspended for the season November 21.

After due advertisement, proposals to build and place one crib 50 by 30 by 18½ feet upon pile foundation, and to dredge the channel, were opened October 28.

Messrs. Squier & White were the lowest bidders for both crib building and dredging.

It was found, however, that so much money would be required to put the outer piers in proper condition and to properly dredge the channel that there would not be a sufficient amount left to pay for the crib at the prices bid. Messrs. Squire & White were therefore notified that contract for the crib would not be closed. A contract for the dredging of the river between the railroad bridge and the town was awarded this firm, and on the 9th of May, 1883, their dredge arrived and began work.

One cut 14 feet deep, 20 feet wide at the bottom, and about 2,500 feet long, and another about 700 feet long, adjoining the first, have been made, extending from the piers up the river, leaving a good channel.

The dredge was then put at work upon the middle ground, making two cuts 14 feet deep and 20 feet wide. This work is between the piers, near the opening, or mouth.

The total amount dredged up to the end of June is 17,449 cubic yards.

The condition of the water outside the piers remains good, and there has been no trouble from shoal water.

The funds available will be expended in repairs upon the pier-heads, which have settled nearly to the water level, and a few minor repairs such as they may be made to cover.

The sum of \$30,000 can be profitably expended upon pier extension under the approved project during the fiscal year ending June 30, 1885, and it is respectfully recommended that this amount be appropriated.

The work is located in the Michigan collection district, Michigan, and is situated at the South Haven light. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work, 1866	\$128,288 47
Whole amount appropriated from 1866 to 1883, inclusive.....	169,500 00
Whole amount expended	165,815 10

Money statement.

July 1, 1882, amount available	\$1,933 65
Amount appropriated by act passed August 2, 1882.....	10,000 00
	<hr/>
	11,933 65
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$6,037 06
July 1, 1883, outstanding liabilities.....	2,211 69
	<hr/>
	8,248 75
July 1, 1883, amount available	3,684 90
	<hr/>
Amount (estimated) required for completion of existing project.....	90,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	30,000 00

Abstract of bids received and opened October 28, 1882, by Maj. D. P. Heap, Corps of Engineers, for improving harbor at South Haven, Mich.

Materials.	No. 1. Squier & White, Grand Haven, Mich.	No. 2. Green's Dredg- ing Company, O. B. Green, president, Chi- cago, Ill.	No. 3. Dewar & Wing, Ludington, Mich.	No. 4. George Talbot, Buffalo, N. Y.
Piles, foundation, in place	\$1 25	.....	\$2 00	\$1 50
Piles, sheet, white oak, in place	30	.....	50	50
White oak timber in place, B. M.	45 00	.....	50 00	50 00
Hemlock timber in place, B. M.	26 00	.....	30 00	35 00
Pine timber in place, B. M.	30 00	.....	40 00	40 00
Screw and washer bolts in place.....	07	.....	08	10
Drift bolts and straps in place.....	05	.....	05	08
Spikes in place	05	.....	08	08
Stone in place	12 00	.....	15 00	15 00
Cedar bark in place	7 00	.....	10 00	10 00
Dredging	19	24	.....	80
Total	6,427 67		8,245 64	8,787 44

* Award recommended.

Contract with Squier & White, of Grand Haven, Mich., dated November 24, 1882, expiring June 30, 1883, for dredging, at 19 cents per cubic yard of material dredged and removed as measured in the dump scows.

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Tabulated statement of commercial statistics, South Haven Harbor, Michigan, from July 1, 1882, to June 30, 1883.

Year ending—	Vessel entered and cleared.	Revenue collected.
June 30, 1883.....	464	\$28 44

II 14.

IMPROVEMENT OF SAINT JOSEPH HARBOR, MICHIGAN.

Work by day labor was begun October 5, 1882, materials being purchased in open market. The south pier, of pile construction, was in bad shape, the filling having become loosened and shaken up through loss of ballast.

One hundred and eighty feet of this work was overhauled and refilled with cedar bark and partly ballasted, so that the pier, as a whole, was left in fair condition for the time being.

Seven hundred linear feet of sand-fences were built, protecting the channel on the south side.

On the north side, the end crib, which had remained without superstructure for three seasons, was superstructured and decked over.

The northwest corner had settled to 3½ feet below water, and several timbers from the walls, as well as some of the cross-ties, had been torn out by the seas.

Protecting the north side of the channel, 760 linear feet of sand-fences were built. A tool-house was erected on a site conveniently near the work, and the removal of the ballast from the east end of the old revetment was begun and continued until 300 linear feet of the work had been cleared.

Work for the season ended December 17, 1882; since which time nothing has been done.

The funds on hand are not sufficient for more than one-fourth of the proposed work, which, when once commenced, should be carried on continuously to completion. The old work is decayed and falling down, and must be replaced.

It is the intention to remove this old work and build a new revetment upon a line indicated upon the accompanying map, which will widen the channel way to 300 feet, causing a slight convergence at the present mouth of the harbor in place of a divergence which now exists, the effect of which change will be very beneficial upon the water outside.

The reports of my predecessors in charge of this work all indicate that the present location of the Chicago and West Michigan Railroad Bridge acts directly against the success of any plan yet proposed for the improvement of this harbor to the extent warranted by its commercial importance and its availability as a haven of refuge from its situation near the south end of the lake. A change in the structure of the bridge would doubtless be of great advantage, but its complete removal is what is required, as by this means only can access to a safe position inside be secured to vessels in heavy weather, even after they have succeeded in getting safely between the piers.

In order to obtain 12 feet of water through the canal leading up to Benton Harbor, widening at the lower end to 100 feet, it is estimated that \$8,000 will be required.

To renew the entire north revetment and pile pier at the channel of entrance, to thoroughly repair the south pier and deepen and widen at its lower end the canal leading up to Benton Harbor, it is estimated that \$60,000 will be required, and it is respectfully recommended that this amount be appropriated for the fiscal year ending June 30, 1885.

The work is located in the Michigan collection district, Michigan, and is situated at the Saint Joseph light. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work as now being carried on	\$128,288 47
Whole amount appropriated since adoption of present project, from 1836 to 1883, inclusive	310,113 00
Whole amount expended	301,508 24

The estimated amount required for the entire and permanent completion of the improvement in accordance with the project adopted is indeterminate.

Money statement.

July 1, 1882, amount available	\$407 22
Amount appropriated by act passed August 2, 1882	12,000 00
	<hr/> 12,407 22
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	3,802 46
	<hr/> 8,604 1
July 1, 1883, amount available	
Amount that can be profitably expended in fiscal year ending June 30, 1885.	60,000 00

Tabulated statement of commercial statistics, Saint Joseph and Benton harbors, Michigan, from July 1, 1882, to June 30, 1883.

Year ending—	Vessels entered and cleared.	Revenue collected.
June 30, 1883	696	\$1,095 56

APPENDIX J J.

IMPROVEMENT OF SAINT MARY'S RIVER; ENLARGEMENT OF, AND OPERATING, SAINT MARY'S FALLS CANAL; IMPROVEMENT OF CERTAIN HARBORS ON LAKE HURON, AND OF SAGINAW RIVER; CONSTRUCTION OF HARBOR OF REFUGE ON LAKE HURON, AND OF ICE-HARBOR AT BELLE RIVER—REPAIR AND PRESERVATION OF SAINT CLAIR FLATS CANAL—IMPROVEMENT OF DETROIT RIVER.

REPORT OF LIEUTENANT-COLONEL O. M. POE, CORPS OF ENGINEERS, BVT. BRIG. GEN., U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|--|--|
| 1. Hay Lake Channel, Saint Mary's River, Michigan. | 9. Ice-harbor of refuge, Belle River, Michigan. |
| 2. Saint Mary's Falls Canal, Michigan. | 10. Operating and care of Saint Clair Flats Ship-Canal, Michigan. |
| 3. Operating Saint Mary's Falls Canal, Michigan. | 11. Clinton River, Michigan. |
| 4. Harbor at Cheboygan, Mich. | 12. Detroit River at Lime Kiln Crossing. |
| 5. Harbor at Thunder Bay, Michigan. | 13. Removing sunken vessels obstructing or endangering navigation. |
| 6. Harbor at Au Sable, Mich. | |
| 7. Saginaw River, Michigan. | |
| 8. Harbor of refuge, Sand Beach, Lake Huron, Michigan. | |

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., August 9, 1883.

SIR: The sad and untimely death of Maj. F. U. Farquhar, on the 3d July, 1883, before he had begun the preparation of his annual report, has, at this late day, devolved that duty upon me, his successor.

Time does not admit of a personal examination of the several works, and lacking the information which could have been obtained in that way, this report becomes essentially that of the assistants directly in charge.

The failure to make any appropriation for river and harbor works for the fiscal year 1883-'84, renders available the estimates for that year, for their continuation for the fiscal year 1884-'85 modified, however, to such an extent as the present condition of the works may seem to require.

* * * * *

After the death of Major Farquhar, Capt. D. W. Lockwood, Corps of Engineers, U. S. Army, was directed to assume temporary charge of the works, and did so.

By paragraph 3, Special Orders No. 172, dated Headquarters of the Army, Adjutant-General's Office, Washington, July 27, 1883, I was or-

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dered to relieve Captain Lockwood of the charge of "the works recently under the charge of the late Maj. Francis U. Farquhar, Corps of Engineers."

The transfer of works could not be immediately made, and it was not until the 10th August that the transfer was actually accomplished, the annual report being completed meanwhile.

I am, sir, very respectfully, your obedient servant,

O. M. POE,
Lieutenant-Colonel of Engineers, &c.,
Bvt. Brig. Gen., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

J J 1.

IMPROVEMENT OF HAY LAKE CHANNEL OF THE SAINT MARY'S RIVER,
VIA THE MIDDLE NEEBISH.

The project upon which this was based is given in paragraph (C) of the special report of Lieut. Col. Godfrey Weitzel, dated January 14, 1882, and printed as House Ex. Doc. No. 54, first session Forty-seventh Congress. It was reprinted in the Report of the Chief of Engineers for 1882, pages 2362 *et seq.* Lieutenant-Colonel Weitzel's estimate of the probable cost of the completed work was \$2,127,292. Of this amount the sum of \$200,000 was appropriated by the act of August 2, 1882, and work is now in progress under a contract with John Hickler, dated February 28, 1883.

I fully concur in the views of Lieutenant-Colonel Weitzel, as expressed in the report referred to, and as the work, even with large appropriations, will require some time for its completion, earnestly recommend that these be made as large as practicable. The proposed improvement is of such a character that a very large force can be advantageously employed upon it. To this end the sum of \$500,000 should be appropriated with which to begin the fiscal year 1884-'85.

More than this could be used, but I deem it useless to ask for more. It will be well to bear in mind the fact that no practical result need be expected until the entire improvement is completed, when the advantages to commerce will be great and manifest, as set forth in the special report.

SURVEYS IN HAY LAKE.

For the purpose of obtaining the data necessary to make a project in detail, for the entire improvement, upon which to base closer estimates than have heretofore been practicable, an accurate survey was early begun and is now in progress. The triangulation has been carried up from the Middle Neebish to Nine-Mile Point, on Sugar Island. This shows that the proposed course from Middle Neebish into Hay Lake will have to be swung a little to the westward in order to clear the shoal off Nine-Mile Point.

TIDE GAUGES.

Tide gauges have been established above and below the Middle Neebish and Little Rapids. Some intermediate ones have been added, and a few days of simultaneous quarter-hourly readings obtained; suitable bench-marks are provided for each gauge. The difference in the elevation of these bench-marks has been determined by precise levels. A Kern level and rods were used, and the method of observation and reduction was the same as that described on page 2426 of the Report of the Chief of Engineers for 1880.

From the few days of simultaneous gauge readings already obtained, it is found that there is a fall of about 9 inches at Little Rapids, and about 8 inches at Middle Neebish Rapids. The two groups of bench-marks have not yet been connected, so that the fall through Hay Lake is still unknown.

DREDGING TEST PITS.

In October, 1882, a dredge owned by John Hickler was employed by the hour and put at work in the Middle Neebish. Pits 19 feet deep and 300 feet apart were dug along the center line of the proposed channel. Five pits in all were dug by the dredge. The last pit was in the shallowest part of the rapids, where the cut in the solid rock would be deepest. This dredge excavated the rock easily, the cost per cubic yard, scow measurement, being about 35 cents. The rock was a soft, stratified sandstone.

In May, 1883, a dredge owned by C. S. Barker was employed by the hour and began digging a test pit 500 feet below the last one of the previous year. This dredge did not succeed in excavating the rock, which seems to be harder in this place. The rock has been blasted, and a depth of 20 feet has been reached.

SURVEY FOR ESTIMATES.

The data for computing the amount of excavation required in the Middle Neebish have been obtained as follows: A line of stakes, each side of the center line of the channel, and 100 feet distant from it, has been driven. These stakes are 260 feet apart in the direction of the current; wooden stakes were driven where possible; where solid rock was found, holes were drilled and bars of railroad iron inserted. Eighty-five stakes in all were required.

A raft 130 feet long and 20 feet wide, with a spud at each end, was anchored with its upper end on line between the first pair of stakes, and on the side in line with the row of stakes. It was swung into position by means of lines and kedges, and held by means of its spuds. Soundings were then made at intervals of 10 feet along each side and through the middle. The raft was then moved sidewise 30 feet, and the operation repeated. This was done seven times, which moved the raft from one line of stakes to the other. It was then dropped down until its lower end was between the second pair of stakes and the operation repeated. The movement sidewise was determined by marks on lines stretched above water between opposite stakes.

This method gives a sounding, at every 10 feet apart, over an area 200 feet wide and 9,000 feet long, or 18,900 soundings in all.

The point, 19 feet above grade, was marked on a suitable number of stakes, and quarter-hourly observations of the water surface were made

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during the time of sounding, and the soundings reduced to what they would have been if the water surface had been 19 feet above grade.

The computation of the contents of the prism is not yet completed. When this is done we will have the means of estimating, with great accuracy, the quantity of material to be removed from this portion of the work; and it is proposed to eventually extend the method over the remaining portion of the projected improvement.

This work is located in the Superior collection district, Michigan. Sault Ste. Marie is a subport of entry, Marquette, Mich., being the nearest port of entry. It is nearly midway between the light-houses at Round Island and Detour.

Money statement.

Amount received from sale of fuel	\$39 39
Amount appropriated by act passed August 2, 1882	200, 000 00
	<hr/> 200, 039 39
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$10, 273 38
July 1, 1883, outstanding liabilities	3, 449 03
	<hr/> 13, 722 41
July 1, 1883, amount available	186, 316 97
	<hr/>
Amount (estimated) required for completion of existing project.....	1, 927, 292 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	500, 000 00

Abstract of bids for dredging on the Middle Neebish, Saint Mary's River, Michigan, received and opened by Maj. F. U. Farquhar, Corps of Engineers, on February 28, 1883, in accordance with advertisement dated January 30, 1883.

No.	Names and residences of bidders.	1. Upper section.		2. Middle section.		3. Lower section.		Total for three sections.	
		Bank measure, per cubic yard. Approximate quantity, 100,000 cubic yards.	Scow measure, per cubic yard. Approximate quantity, 125,000 cubic yards.	Bank measure, per cubic yard. Approximate quantity, 100,000 cubic yards.	Scow measure, per cubic yard. Approximate quantity, 140,000 cubic yards.	Bank measure, per cubic yard. Approximate quantity, 100,000 cubic yards.	Scow measure, per cubic yard. Approximate quantity, 140,000 cubic yards.	Bank measure, per cubic yard. Approximate quantity, 300,000 cubic yards.	Scow measure, per cubic yard. Approximate quantity, 405,000 cubic yards.
1	John Hickler, Buffalo, N. Y	\$0 72	\$0 62	\$0 72	\$0 62	\$0 72	\$0 62	\$216, 000	\$251, 000
2	Williams & Upham, L'Anse, Mich	75	60	75	60	75	60	225, 000	243, 000
3	David W. McConnell, Buffalo, N. Y	79	70	79	70	85	75	243, 000	290, 500
4	Harry Fox & Co., Chicago, Ill.	90	67	90	67	90	67	270, 000	271, 350
5	James Rooney, Toledo, Ohio	1 00	68	1 00	68	1 00	68	300, 000	275, 400
6	Charles S. Barker, Sault Ste. Marie, Mich.	95	63	1 25	70	1 25	70	245, 000	274, 750
7	Carkin, Stickney & Cram, East Saginaw, Mich.	1 25	65	1 25	65	1 25	65	375, 000	263, 250
8	Chicago Dredging and Dock Company, Chicago, Ill.		72		72		72		291, 000
9	Norris G. Dodge, Little Falls, N. Y		75		85		90		338, 750
10	Christian Schwarz, Fort Howard, Wis.		66		82		82		312, 100
11	Horatio Freeman, Manitowoc, Wis.		83		88		83		336, 150
12	Green's Dredging Company, Chicago, Ill.		71						
13	Edward Moore, Portland, Me.		1 65						

Contract awarded to John Hickler. Bank measurement recommended for acceptance.

J J 2.

IMPROVEMENT OF THE SAINT MARY'S FALLS CANAL AND SAINT MARY'S RIVER, MICHIGAN.**IMPROVING THE CANAL.**

Although the canal has been available for practical navigation since the 1st September, 1881, yet much has remained and still remains to be done, in order to fully complete the work. During the fiscal year the following has been accomplished:

In October, 1882, three cribs were sunk above and two below the new lock. These form an extension to the west and east bulkheads. The superstructure was completed in May, 1883. A slope wall, beginning near the pump-house, and extending southward 250 feet, with an average height of 20 feet along the face, has been built, mostly by the lockmen when not engaged in locking. In the same way a small house for tools, near the movable dam, and a scow 96 feet long by 18 feet wide, and 5 feet deep, has been built.

IMPROVING THE RIVER.

Two dredges belonging to John Hickler were employed by the hour in deepening the approaches above and below the canal. The average increase in the depth of water was 4 feet, to accomplish which 10,912 cubic yards of material, scow measurement, were removed. The dredges were employed on this work a total of one thousand and sixty hours.

After the dredging was completed the drill-scow was brought up from Sailor's Encampment, and the bowlders removed from three-fourths of the area. The drill-scow was employed on this work thirty-four days.

The drill-scow with a party of twelve men, under charge of Mr. Hursley, worked seventy-seven days on the shoal near Sailor's Encampment. The bottom was first drilled and blasted, and the broken fragments of rock were then chained by a diver, and hoisted onto the scow. In this way an area of 1,200 square yards of bottom was cleaned to a depth of 17 feet, making a straight channel 100 feet wide, with a uniform depth of 17 feet, over this shoal. An area of about 2,700 square yards, having an average depth of 15 feet of water, still remains.

During the winter the drill-scow was strengthened by a system of bracing extending from each corner to the one diagonally opposite.

A house that was formerly used on the river survey has been placed on a scow belonging to the Government, refitted, and is now in use at the Middle Neebish; it will accommodate six officers and twelve men.

EAST NEEBISH.

The west channel of East Neebish was completed in August, 1882. This channel is now 150 feet wide, 17 feet deep.

The dredging was done by two dredges owned by John Hickler, working by the hour. The bowlders were picked up by the crane-scow.

The amount of material removed was 14,361 cubic yards. The area dredged over was 10,420 square yards. The dredge was at work one thousand two hundred and eighty hours, and the crane-scow three hundred and seventy hours.

DREDGING IN LAKE GEORGE.

This work was under contract of September 22, 1881, with Charles S. Barker, and was finished in November, 1882, giving a 17-foot channel through Lake George.

The final survey and estimate was made in January, 1883, by Assistant Engineer Ripley, the soundings being made through holes out in the ice; eleven thousand soundings were required.

The work was accepted, as completed, in February, 1883, and no estimate is submitted for a further appropriation.

SETTING OUT BUOYS.

There are fifty-three buoys in Saint Mary's River, which require to be located very accurately (say within 6 feet), in order to get the full benefit of the channel. They are located from intersections given by two observers with theodolites, stationed on shore. For the last year this work was done as part of the improvement. The method is as follows, viz:

The azimuth of the site of each buoy has been computed from two or more stations. An observer with theodolite, signalman, and flag, is placed at each of the stations in pairs; the stations being usually inter-visible. The observers orient their instruments by pointing at each other, with proper readings. The azimuth to the buoy is then turned off. An assistant in a small boat places a small buoy, called a "marker," at the intersection of the two azimuths, which is indicated by the proper signals from the observers. This work occupied three assistants and seven men, with the tug Myra, one week.

Appended is a sketch* showing the location of the stations used; also tables giving the co-ordinates of the stations, and the azimuths of stations from each other, and to the buoys. The stations are usually cedar posts, surrounded by a pile of stones, with the number of the station cut in the top of the post.

The tables were prepared by Mr. Noble, when he was in charge of the work, and it is thought advisable to preserve them in this form for future reference.

The *number* of each buoy and its *location* are those given in the list of beacons, buoys, and stakes in the eleventh light-house district for the year 1883.

HEIGHT OF SURFACE OF WATER IN LAKE SUPERIOR.

Tide-gauge observations have been made at Sault Ste. Marie for thirteen years. At first they were made by the United States Lake Survey. Afterwards they were made by the Saint Mary's River Improvement and the data furnished to the United States Lake Survey, which published them up to October, 1881.

The observations have all been collected and reduced to the canal datum. The mean for each month has been taken. These means have been plotted in a form of a curve* which is given on the following page. The date is the abscissa, and the height of the water surface above the canal datum is the ordinate.

The mean yearly curve has been found by taking the mean of all the January means, then of all the February means, and so for each month.

* Not printed.

These means when plotted give a very symmetrical curve which is shown by the dotted line on the following plot.* It will be seen that the average yearly range in height is 1.2 feet. The line of high water is August and September, and of low water, March and April.

Money statement.

July 1, 1882, amount available	\$74,054 66
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$70,597 19
July 1, 1883, outstanding liabilities	332 31
	<hr/> 70,929 50
July 1, 1883, amount available	<hr/> 3,125 16

* Not printed.

5455—E 83—116

Table of co-ordinates and azimuths used in setting buoys, Saint Mary's River, Michigan.

No.	Description.	Location.	At-	Azimuth to buoy.	At-	Azimuth to buoy.	At-	Azimuth to buoy.	Stations.	Azimuth.	Stations.	Co-ordinates.			
												North.	East.	South.	West.
				° ' "		° ' "		° ' "		° ' "		Feet.	Feet.	Feet.	Feet.
7	Black.	Reals Island	65	2 26 14	364	91 45 29	66	337 40 33	634	141 23 28.3	65	60,757.77	60,757.77	60,595.78	60,595.78
4	Red.	Reals Point	62	213 37 07.8	64	250 06 59.5	63	190 49 59	65	139 02 28.9	66	60,245.79	60,245.79	58,186.96	58,186.96
9	Black.	Mirror Point	62	222 01 29.7	64	263 02 48.7	63	328 39 43.5	65	174 39 41.3	66	59,636.37	59,636.37	58,303.93	58,303.93
6	Red.	Channel buoy	62	230 37 02.8	64	277 42 20.4	63	337 27 16.6	65	192 49 19.1	66	58,355.84	58,355.84	58,018.96	58,018.96
8	Red.	Point of Woods	62	285 48 50.1	61	43 34 40.9	64	306 52 35.5	65	149 20 32.1	66	57,314.06	57,314.06	56,965.47	56,965.47
11	Black.	do	62	283 24 29.0	61	33 39 48.0	64	303 47 23.7	65	23 04 42.3	66	57,527.07	57,527.07	56,448.39	56,448.39
13	do	Little Mud Lake	36	210 31 12.4	55	129 55 37.6	59	19 49 17.1	62	257 11 42.3	61	54,854.72	54,854.72	53,615.57	53,615.57
10	Red.	Scribble's Point	55	109 59 03.1	55	36 298 04 22.7	56	298 04 22.7	61	282 43 05.1	61	53,480.92	53,480.92	52,233.90	52,233.90
12	do	Saint Joseph's Island	55	113 21 54.3	32	164 45 15.5	32	164 45 15.5	59	260 49 04.2	59	53,046.00	53,046.00	51,847.10	51,847.10
15	Black.	Harwood's Point	55	107 43 55.2	32	166 22 03.3	32	166 22 03.3	59	356 35 53.1	59	54,289.72	54,289.72	53,783.53	53,783.53
17	do	Lower	55	77 06 36.6	32	164 46 58.9	32	164 46 58.9	55	352 15 19.2	55	54,680.94	54,680.94	53,284.97	53,284.97
14	Red.	Neeliah Shoal	30	182 06 30.7	47	138 55 42.4	47	12 54 37.7	32	3 40 03.5	47	53,999.35	53,999.35	52,648.41	52,648.41
19	Black.	American channel	43	155 25 00	43	176 19 00	43	200 45 45	45	183 40 03.5	45	53,527.07	53,527.07	52,166.13	52,166.13
21	do	West bank	43	165 05 00	43	273 17 00	43	273 17 00	45	327 15 58.2	45	53,046.91	53,046.91	51,847.10	51,847.10
16	Red.	East bank	43	217 39 00	43	273 17 00	43	273 17 00	45	327 15 58.2	45	53,046.91	53,046.91	51,847.10	51,847.10
23	Black.	American cut	A	223 57 04	B	264 35 49	B	264 35 49	23	247 47 24.7	23	40,636.16	40,636.16	39,384.09	39,384.09
18	Red.	Lower entrance	A	229 08 32	B	268 10 44	B	268 10 44	23	234 52 00.6	23	40,636.16	40,636.16	39,384.09	39,384.09
25	Black.	do	A	236 05 09	B	304 09 50	B	304 09 50	23	271 15 23.4	23	39,069.24	39,069.24	37,816.97	37,816.97
20	Red.	Upper entrance	A	234 06 53	B	307 08 17.6	B	307 08 17.6	23	313 36 56.7	23	40,474.70	40,474.70	39,220.44	39,220.44
24	do	Lake George cut	37	26 09 51.1	24	279 50 01.8	24	279 50 01.8	34	286 47 19.6	34	40,636.16	40,636.16	39,384.09	39,384.09
27	Black.	Lower entrance	37	16 43 26.8	24	284 19 13.9	24	284 19 13.9	33	289 08 18.6	33	40,636.16	40,636.16	39,384.09	39,384.09
26	Red.	do	37	8 44 57.6	24	311 33 04.7	24	311 33 04.7	32	140 81 23.0	32	38,061.06	38,061.06	36,742.00	36,742.00
29	Black.	Second buoy	37	5 23 18.7	24	310 27 02.5	24	310 27 02.5	31	8 361.30	31	3,048.30	3,048.30	22,950.44	22,950.44
37	do	do	38	139 43 52.8	35	70 16 05.3	35	70 16 05.3	31	286 37 20.5	31	255 03 54.6	255 03 54.6	24,147.24	24,147.24
42	Black.	Sixth buoy	38	81 49 22.9	35	38 03 55.5	35	38 03 55.5	30	255 03 54.6	30	7,087.83	7,087.83	55,006.15	55,006.15
46	Red.	Tenth buoy	38	77 49 38	35	31 03 31	35	31 03 31	29	136 24 18.6	29	228 19 16.8	228 19 16.8	21,210.82	21,210.82
44	Red.	do	38	75 27 42.3	35	32 22 08.3	35	32 22 08.3	29	166 09 45.9	29	19,090.06	19,090.06	1,817.16	1,817.16
47	Black.	Upper entrance	38	70 27 37.5	35	37 25 07.1	35	37 25 07.1	27	233 13 45.7	27	10,408.93	10,408.93	2,008.42	2,008.42
49	do	Churchville Point	32	182 51 37.5	31	87 35 07.1	31	87 35 07.1	26	109 50 15.1	26	14,490.01	14,490.01	2,008.42	2,008.42
48	Red.	Squirrel Island	16	518 36 30.1	37	26 19 13.8	37	26 19 13.8	20	109 50 15.1	20	14,490.01	14,490.01	2,008.42	2,008.42
51	Black.	Churchville Mill	31	31 38 07.3	37	26 19 13.8	37	26 19 13.8	20	109 50 15.1	20	14,490.01	14,490.01	2,008.42	2,008.42
50	Red.	Point Charles	31	31 38 07.3	37	26 19 13.8	37	26 19 13.8	20	109 50 15.1	20	14,490.01	14,490.01	2,008.42	2,008.42

	Black.	Palmer's Point: (Shoal)	21	333 48 51.3	19	91 51 21.7	34	102 06 42.8	14-□	4	311 54 28.1	21	2, 504. 10	17, 000. 25	
58	do	Palmer's Point:	□	290 52 57.9	□	19 345 49 46.0	△	98 06 02.7	□	5-A 3	71 33 53.2	△	2, 206.74	19, 785.35	
59	do	(Sand Flats)	△	280 34 30.0	□	18 346 28 28.4	△	86 26 53.2	□	7-A 3	214 40 20.8	△	10, 401.80	26, 457.30	
53	Red.	(Little Lake George).	△	285 34 30.0	□	351 29 38.4	△	29 07 42.4	△	15-A L. H.	263 26 04.7	□	8, 890.50	54, 248.01	
57	Black.	Pointe aux Pins	△	4 13 38.2	△	20 55 56 56.7	△	31.328 33 25.8	□	7-A 15	58 00 07.5	△	17, 424.50	61.62	
54	Red.	Cass Point.	△	29	△	29	△	20 87 17 52.8	△	10-A L. H.	183 32 55.6	△	15, 077.23	567.11	
56	do	Farmer's Ridges:	△	244 23 20.1	△	312 37 27.1	△	29 256 10 55.3	△	43-□ B.	132 47 25.8	△	4, 934.60	3, 153.02	
63	Black.	Shoal first buoy	△	68 27 26.2	△	16 34 57.5	△	29 256 55 43.0	□	43-□ A.	108 57 17.2	△	10, 104.14	733.74	
63	Black.	Shoal second buoy	△	18 64 23 53.1	△	2 02 42.8	△	29 247 44 22	□	43-□ A.	211 51 56.5	△	13, 079.88	47, 068.71	943.49
65	Red.	Shoal third buoy	△	18 86 57 03.1	△	344 11 11.1	△	18 161 52 49.8	□	43-□ A.	12 547.11	△	3, 726.10	1, 186.85	
67	do	Shoal fourth buoy	△	16 90 00 00	△	60 19 23.4	△	14 99 09 52.9	□			□	1, 365.53		8, 968.78
71	do	Shoal fifth buoy	△	16 247 00 11.5	△	314 31 43	△	14 94 45 20.3	□			□	2, 284.43	6, 741.21	14, 002.09
60	Red.	Marchand's Rock	△	256 47 16.5	△	316 53 12.3	△	4 133 18 46.6	□			□	3, 550.62	52, 479.11	53, 130.88
63	do	Channel buoy	△	258 29 55	△	175 23 24	△		□			□	54, 202.61	53, 712.70	
64	do	Topesail Island	△	14 215 46 28.2	△	143 24 17.6	△		□			□	54, 457.83	54, 980.34	
73	Black.	Channel buoy	△	14 211 46 08.8	△	146 18 39.0	△		□			□			
75	do	Mission Point.	△	14 248 07 54.7	△	155 54 53.6	△		□			□			
66	Red.	Brown's Point.	△	14 278 56 36.2	△	218 00 03.2	△		□			□			
68	Red.	Vidal's Shoal.	△	5 14 38 16.5	△	303 19 33.3	△	7 254 45 28.8	□			□			
72	Red.	Opposite Round Is.	△	15 344 54 45.6	△	39 06 10	△	7 13 37 41.2	□			□			
		and Point.	△		△										
77	Black.	Round Island Point.	△	41 28 35.6	△	15 344 53 83.8	△	7 15 19 31.4	□						
70	Black.	Opposite Middle Ground.	△	223 02 39.1	△	237 36 37.7	△								

NOTE.—The stations △ L. H., △ 15, △ 10, and □ 7 are referred to a system of co-ordinates whose origin is △ 11. All the others are referred to △ 19. The two systems are not yet connected.

1844 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Table of buoy estimates arranged for use in field.

OBSERVER A.										OBSERVER B.									
From station.	To station.	Azimuth to	Description.	Location.	Azimuth to	Number of	From station.	To station.	Azimuth to	Description.	Location.	Azimuth to	Number of						
634	65	141 23 23.3	Black.	Rains Island.	321 23 23.3	7	65	634	321 23 23.3	Black.	Rains Island.	0	7						
635	61	213 37 07.8	Red.	Reed's Point.	213 37 07.8	4	64	61	213 37 07.8	Red.	Reed's Point.	259 06 50.5	4						
636	62	227 11 42.3	Black.	Mirro's Point.	227 11 42.3	9	64	62	227 11 42.3	Black.	Mirro's Point.	263 03 48.7	9						
637	63	230 37 02.8	Red.	Channel buoy.	230 37 02.8	6	64	63	230 37 02.8	Red.	Channel buoy.	277 42 20.4	6						
638	63	235 43 50.1	do.	Point of Woods.	235 43 50.1	8	61	63	235 43 50.1	do.	Point of Woods.	33 24 40.9	8						
639	62	238 24 29.0	Black.	do.	238 24 29.0	11	61	62	238 24 29.0	Black.	do.	33 39 43.0	11						
640	62	240 49 04.2	do.	Little Mud Lake.	240 49 04.2	13	59	62	240 49 04.2	do.	Little Mud Lake.	129 55 37.6	13						
641	55	252 16 19.2	Red.	Scribble's Point.	252 16 19.2	10	55	55	252 16 19.2	Red.	Scribble's Point.	199 59 08.1	10						
642	55	258 04 22.7	Red.	Saint Joseph's Island.	258 04 22.7	13	55	55	258 04 22.7	Red.	Saint Joseph's Island.	113 21 54.3	12						
643	55	183 40 03.5	Red.	North Shoal.	183 40 03.5	12	55	55	183 40 03.5	Red.	North Shoal.	113 21 54.3	12						
644	55	184 45 15.5	Red.	Harwood's Point.	184 45 15.5	12	55	55	184 45 15.5	Red.	Harwood's Point.	107 42 55.2	15						
645	55	185 22 08.8	Black.	Lower.	185 22 08.8	15	55	55	185 22 08.8	Black.	Lower.	77 06 36.6	17						
646	55	186 45 52.9	do.	Upper.	186 45 52.9	17	55	55	186 45 52.9	do.	Upper.	133 56 43.4	14						
647	55	187 05 30.7	Red.	Neebish Shoal.	187 05 30.7	14	45	55	187 05 30.7	Red.	Neebish Shoal.	181 01 00	19						
648	45	284 30 04.2	Red.	American channel.	284 30 04.2	14	45	45	284 30 04.2	Red.	American channel.	248 20 00	21						
649	45	188 22 02.6	Black.	West bank.	188 22 02.6	19	45	45	188 22 02.6	Black.	West bank.	273 17 00	16						
650	45	233 37 17.2	do.	do.	233 37 17.2	21	45	45	233 37 17.2	do.	do.	286 10 44	18						
651	45	211 51 59.5	Red.	East bank.	211 51 59.5	16	45	45	211 51 59.5	Red.	East bank.	284 85 49	23						
652	45	155 35 00	do.	American cut.	155 35 00	19	45	45	155 35 00	do.	American cut.	307 08 17.6	20						
653	45	229 08 32	do.	Lower entrance.	229 08 32	18	45	45	229 08 32	do.	Lower entrance.	304 09 50	25						
654	45	232 57 04	Black.	do.	232 57 04	23	45	45	232 57 04	Black.	do.	26 09 51.1	24						
655	45	254 06 53	Red.	Upper entrance.	254 06 53	20	45	45	254 06 53	Red.	Upper entrance.	16 43 29.8	27						
656	45	256 05 06	Black.	do.	256 05 06	25	45	45	256 05 06	Black.	do.	8 44 57.0	26						
657	45	279 50 01.8	Red.	Lake George cut.	279 50 01.8	24	45	45	279 50 01.8	Red.	Lake George cut.	6 22 18.7	29						
658	45	284 19 19.9	Black.	Lower entrance.	284 19 19.9	27	45	45	284 19 19.9	Black.	Lower entrance.	180 43 52.8	37						
659	45	311 33 04.7	Red.	Second buoy.	311 33 04.7	26	45	45	311 33 04.7	Red.	Second buoy.	81 48 22.9	42						
660	45	310 27 02.5	Black.	do.	310 27 02.5	29	45	45	310 27 02.5	Black.	do.	75 49 08	40						
661	45	79 16 06.3	do.	Sixth buoy.	79 16 06.3	37	45	45	79 16 06.3	do.	Sixth buoy.	75 49 08	40						
662	45	33 03 55.5	Red.	Tenth buoy.	33 03 55.5	42	45	45	33 03 55.5	Red.	Tenth buoy.	77 49 08	45						
663	45	81 08 31	do.	do.	81 08 31	45	45	45	81 08 31	do.	do.	77 49 08	45						
664	45	82 22 09.8	Black.	Upper entrance.	82 22 09.8	44	45	45	82 22 09.8	Black.	Upper entrance.	75 49 08	40						
665	45	130 51 27.3	Red.	do.	130 51 27.3	47	45	45	130 51 27.3	Red.	do.	75 49 08	40						
666	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
667	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
668	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
669	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
670	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
671	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
672	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
673	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
674	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
675	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
676	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
677	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
678	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
679	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
680	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
681	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
682	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
683	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
684	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
685	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
686	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
687	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
688	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
689	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
690	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
691	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
692	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
693	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
694	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
695	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
696	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
697	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
698	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
699	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
700	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
701	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
702	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
703	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
704	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
705	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
706	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
707	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
708	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
709	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
710	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
711	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
712	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
713	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
714	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
715	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75 49 08	40						
716	45	130 51 27.3	do.	Upper entrance.	130 51 27.3	47	45	45	130 51 27.3	do.	Upper entrance.	75							

16	Black	308 15 07.1	51	□ 37	□ 19	239 03 18.6	Black	Church's Mill	19 21 50	51
17	Red	91 48 40.4	50	△ 34	□ 19	239 03 18.6	Red	Point Charles	180 55 24	50
18	Black	91 51 21.7	53	△ 34	□ 19	239 03 18.6	Black	Palmer's Point Shoal	192 06 42.8	53
19	do	345 49 46	55	△ 34	□ 19	239 03 18.6	do	Palmer's Point	280 52 57.9	55
19	Red	345 30 06.4	52	△ 34	□ 19	239 03 18.6	Red	Sand Flat, Little Lake	285 34 30	52
27	Black	29 07 42.4	57	△ 30	△ 37	225 16 45.3	Black	George	351 29 38.4	57
29	Red	4 12 38.2	54	△ 30	△ 37	225 16 45.3	Red	Pointe aux Pins	355 58 58.7	54
29	do	312 37 27.1	56	△ 20	△ 27	186 24 18.6	do	Farmer's Ridge:	81 17 52.8	56
27	Black	16 34 57.5	63	△ 18	△ 27	186 24 18.6	Black	Shoal, first buoy	66 27 26.2	63
27	Red	2 02 42.8	58	△ 18	△ 27	186 24 18.6	Red	Shoal, second buoy	64 23 33.4	58
25	Black	341 11 11.1	65	△ 18	△ 25	186 09 45.9	Black	Shoal, third buoy	86 57 03.1	65
25	do	60 19 28.4	67	△ 18	△ 25	186 09 45.9	do	Shoal, fourth buoy	90 00 00	67
25	do	814 31 43	71	△ 16	△ 25	186 09 45.9	do	Shoal, fifth buoy	247 00 11.5	71
25	Red	316 53 12.3	60	△ 16	△ 14	268 04 51.2	Red	Marchand's Rock	256 47 16.5	60
14	do	175 28 24	62	△ 16	△ 14	268 04 51.2	do	Channel buoy	258 29 55	62
4	do	143 24 17.6	64	△ 14	△ 4	311 54 26.1	do	Topail Island	215 46 28.2	64
4	Black	146 18 26.0	73	△ 14	△ 4	311 54 26.1	Black	Channel buoy	211 46 03.8	73
4	do	155 54 53.6	75	△ 14	△ 4	311 54 26.1	do	Mission Point	248 07 54.7	75
4	Red	218 00 03.2	66	△ 3	□ 5	261 33 53.2	Red	Brown's Point	278 56 38.2	66
5	do	14 38 16.5	68	△ 3	□ 5	261 33 53.2	do	Bayfield's Rock	303 19 33.3	68
15	do	39 06 10	72	△ 15	△ L. H.	253 26 04.7	do	Vidal's Shoal	344 54 45.6	72
15	do	41 23 35.6	77	△ 15	△ L. H.	253 26 04.7	do	Opposite Round Island	344 53 33.8	77
15	Black	297 36 37.7	79	△ 10	△ L. H.	188 33 55.6	Black	Round Island Point	322 02 38.1	79
15	do			△ 10	△ L. H.	188 33 55.6	do	Opposite Middle Ground		

J J 3.

OPERATING AND CARE OF SAINT MARY'S FALLS CANAL, MICHIGAN.

On the 1st September, 1882, Mr. E. S. Wheeler was appointed general superintendent of the canal and assistant engineer in charge of the improvement of Saint Mary's River, vice Mr. Alfred Noble, resigned. He entered upon his duties at the work on the 9th of the same month, and found the following organization upon the work engaged upon both works.

Joseph Ripley, assistant engineer, temporarily in charge; E. C. Burns, assistant engineer; Herman Werner, draughtsman; Richard Common, jr., and Frank Reed, sub-inspectors; and solely in operating and caring for the canal, John Spalding, superintendent of new lock; William Chandler, superintendent of old lock; Andrew Jackson, clerk; George Reynolds, assistant superintendent of new lock; Charles Spalding, assistant superintendent of old lock; and this organization has remained unchanged.

Besides the foregoing, there are employed one first engineer, one second engineer, one foreman, four watchmen, nineteen lockmen, the whole force being divided into two watches, the superintendent and assistant superintendent of the old lock taking charge of the morning watch, and the superintendent and assistant superintendent of the new lock taking the afternoon watch. Each watch is twelve hours long. At present but little use is made of the locks between 8 p. m. and 4 a. m., but if a vessel desires to pass during that time she is promptly locked through. The cause of this interval of comparative leisure is the difficulty of navigating the river below the canal at night.

The officers and men of the regular lock force have provided themselves with badges and a plain uniform, which improves the discipline and enables those using the locks to readily recognize the persons in authority.

ACCIDENTS AND DELAYS IN THE LOCKS.

Two sailors have been injured by lines while passing through the locks; one of them lost both feet, and the other lost one. Both were cared for by the military authorities at Fort Brady.

On the 2d August, 1882, the steam barge Osceola ran against the lower gates of the new lock at a speed variously estimated at from 1 to 5 miles per hour (the latter estimate is evidently much too high). The accident was caused through a misunderstanding of the engineer of the boat as to the bell signals. The gate resisted the shock, but was somewhat injured. Some of the planking and timbers were crushed and several iron straps were broken. The injuries were promptly repaired and no delay occurred.

On the 3d of October, 1882, one of the lower valves of the new lock ceased to work. The lock was pumped out, when it was found that the pipe connecting with the valve engine was broken at one of the elbows. This was repaired and the lock opened after having been closed forty-four hours. The weather was thick most of this time, consequently but few vessels reached the canal; except one barge which was detained three hours, all were passed through the old locks without detention.

The wire rope which closes the lower south gate of the new lock was broken on the 8th of May, 1883. There was some floating ice in the lock, and the pull was harder than usual. The rope was old, having been in use from the first opening of the canal. The lock was pumped out and the broken rope replaced by a new one. The lock was closed for twenty-

four hours, but no detention to vessels occurred, as all that arrived were promptly passed through the old locks.

On the 20th May, 1883, the pipe connecting the main pipe with the south wall engine broke at the elbow. It was repaired in two hours, without detention to shipping.

IMPROVEMENTS IN THE LARGE PUMP.

The large centrifugal pump with which the water is pumped out of the lock has proved inefficient. It is placed 8 feet below the surface of the water, and for the first 16 feet lowers the water in the lock at the rate of 1 foot per hour. Its efficiency then rapidly diminishes, and after the water is lowered about 2 feet below the bottom of the lock it stops work. This leaves about 7 feet of water in the culvert. Whenever it has been necessary to clear the culvert an auxiliary steam-pump has been used.

An examination of the pump showed that the feathers were about 1 inch smaller than the scroll. The feathers were enlarged so as to very nearly fill the scroll. The pump then lowered the water so that there was but 2 feet and 5 inches in the culvert. At this point the packing around the shaft gave out. It is believed that with some slight improvements in the stuffing-box this pump will be able to entirely clear the culvert.

The old locks were closed on the 14th June, 1882, in order that some necessary work might be done at their lower end. This was completed and the locks reopened soon after the 1st July following. The canal was closed for the winter on December 3, 1882, and reopened for navigation on May 2, 1883, hence was open for use during the fiscal year two hundred and sixteen days.

The total number of passages through the canal during the fiscal year was 4,163, with 2,330 lockages. The registered tonnage of the passing vessels was 2,130,181 tons, carrying 28,401 passengers and 1,874,404 tons of freight. It will be noticed that whilst the registered tonnage during the year was 249,035 tons less than for the preceding year, the actual freight passed was only 3,750 tons less. This is doubtless due to the improvement in the channel of the river, which now admits of deeper draught and heavier loading.

The average duration of lockage through the old locks was forty minutes, and through the new lock thirty-five minutes.

The average cost of passing a ton, registered, was $1\frac{3}{4}$ cents, and of a ton freight about $1\frac{1}{16}$ cents.

Altogether, the canal, with its double system of lockage, has continued to prove in the highest degree satisfactory.

EXPENDITURES AND RECEIPTS FOR FISCAL YEAR 1882-'83, AND ESTIMATE FOR 1883-'84.

The actual expenditures on account of operating and caring for the canal during the fiscal year 1882-'83 amount to \$35,509.70, and the receipts (from dry-docking and rents) to \$736.

The following estimate of the probable cost of operating and caring for the canal during the fiscal year ending June 30, 1884, is respectfully submitted.

The regular canal force, as at present organized, is given in a preceding paragraph. The pay-roll of this force is estimated at \$19,000.

The labor partly consists of one foreman and such laborers as are necessary to carry on the needed repairs and betterments, such as new superstructure to the old and new piers, grading the ground south of new lock, &c. The estimated pay-roll for this party is \$10,000.

1848 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

The principal items of supplies are stationery for office, lumber for repairs of piers, lock-gates, and buildings, oil for lighting locks and office, paints and oils for painting gates, buildings, &c., rope and wire rope for operating locks, fuel for pump-house and office, hardware and iron, oakum, waste and freight on material. The estimated cost of these necessary supplies is \$6,000.

RECAPITULATION.	
Receipts 1882-'83	\$736 00
Expenditures 1882-'83	35,509 70
Net cost of operating and caring for the canal, 1882-'83	34,773 70
ESTIMATE FOR YEAR 1883-'84.	
Pay-roll of regular force	\$19,000 00
Pay-roll for labor party	10,000 00
Purchase of supplies	6,000 00
Total	35,000 00

No estimate of receipts is made, because they are so very uncertain that no dependence can be placed upon them.

FURTHER REQUIREMENTS OF THE CANAL.

As to the further requirements of the canal, I respectfully invite attention to the special report of Lieutenant-Colonel Weitzel, dated Detroit, Mich., January 14, 1882, printed as House Ex. Doc. No. 54, Forty-seventh Congress, first session, and reprinted with the report of the Chief of Engineers for 1882, beginning at page 2358, and particularly referred to in paragraphs (b) and (d) of that report. I fully concur in the reasons assigned by Lieutenant-Colonel Weitzel for making the proposed improvements.

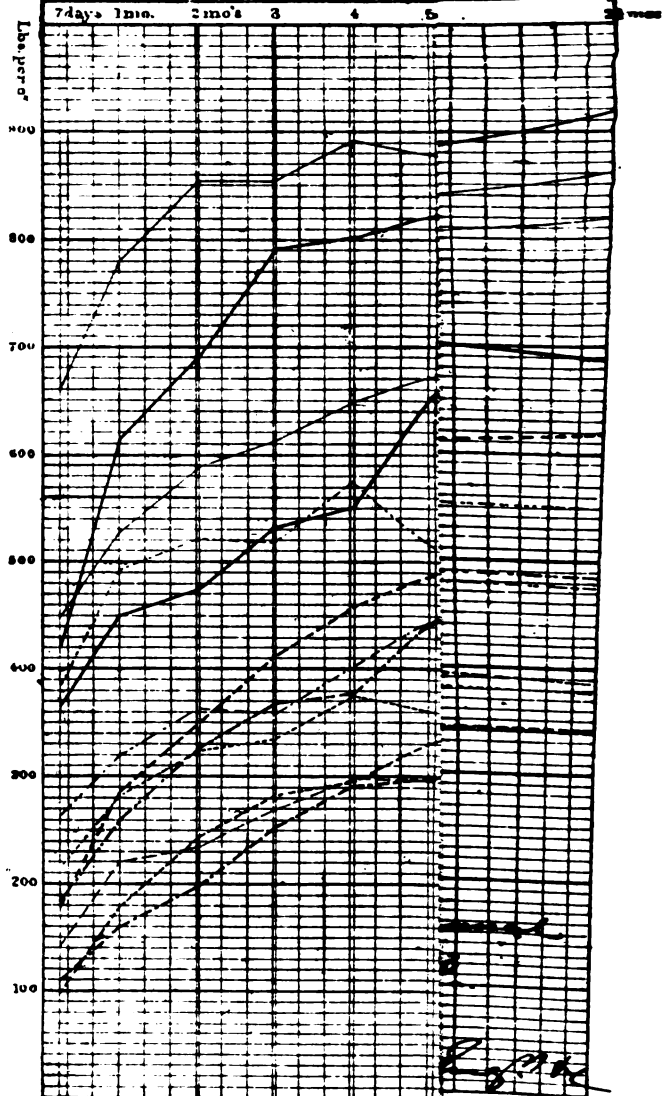
But I cannot but think his estimate of the cost of converting the upper chamber of the old locks into a dry-dock entirely too low. The very late day at which I was assigned to the charge of the work does not admit of my going into an examination of this question, nor do I think it particularly necessary, as I am decidedly of opinion that any dry-dock made here should be wholly independent of the system of lockage. I therefore respectfully recommend that Lieutenant-Colonel Weitzel's project for such a construction be adopted. The probable cost of the work is estimated at \$313,878, of which amount the sum of \$100,000 could be profitably used for the operations of one season.

If this project be authorized, the question of deepening the old locks and improving their operating machinery can be taken up with a view to completion by the time they will be urgently needed.

Statement of receipts and expenditures at Saint Mary's Falls Canal, Michigan, during the fiscal year ending June 30, 1883.

Receipts.		Expenditures.	
Source.	Amount.	For what purpose.	Amount.
Dry-docking	\$536 00	Office expenses	\$1,890 32
Rents	200 00	General purchases	2,350 63
		Repairs	5,072 63
		Labor operating canal	17,286 50
		Extra labor	7,961 00
		Lights on locks	216 85
	736 00		35,509 70

A, a, a, Knight, Beran and S
B, b, b, White Bros
C, c, c, Pea green label S.T.
D, d, d, Blue label



STATEMENT OF THE BUSINESS OF THE SAINT MARY'S FALLS CANAL, MICHIGAN, FOR
THE FISCAL YEAR ENDING JUNE 30, 1883.

Number and class of vessels passed :

Side-wheel.....	134
Propeller.....	2,362
Sail.....	1,356
Rafts and craft not registered.....	311
Total number.....	4,163
Registered tonnage.....	2,130,181

Freight and passenger traffic through canal :

Coal.....	tons.....	464,320
Copper.....	do.....	25,937
Flour.....	barrels.....	427,866
Grain.....	bushels.....	5,068,417
Iron ore.....	tons.....	804,766
Pig and manufactured iron.....	do.....	78,909
Lumber.....	feet, B. M.....	74,734,000
Salt.....	barrels.....	107,835
Miscellaneous.....	tons.....	171,308
Total freight.....	do.....	1,874,404
Passengers.....	.....	28,401

The canal was opened for navigation two hundred and sixteen days during the year. It was closed for the winter on December 3, 1882, and opened on May 2, 1883.

Statement of number of vessels passed through the Saint Mary's Falls Canal, Michigan, with number, time, and cost of lockages, during the fiscal year ending June 30, 1883.

Items.	Through old lock.	Through new lock.	Totals and means.
Number of vessels.....	213	3,950	4,163
Number of lockages.....	165	2,165	2,330
Registered tonnage.....			2,130,181
Tons of freight.....			1,874,404
Time per vessel.....	minutes.....	19	25
Time per lockage.....	do.....	35	37½
Time per vessel, during which vessels were in locks.....	do.....	34	34
Cost per vessel.....			8 56
Cost per lockage.....			15 43
Cost per ton registered.....			0.0167
Cost per ton freight.....			0.0180

NOTE.—Cost includes all repairs and improvements made by the operating force, and all purchases therefor.

CEMENT TESTS.

A report on cement tests was made by Mr. Noble to General Weitzel, page 2345, Report of Chief of Engineers, 1882.

The series of tests at that time were incomplete. They have since been completed in the same manner as begun. Mr. Noble's interest in these tests still continues.

A copy of the notes has been sent him which he has reduced and plotted up to March, 1883. The few observations made since then have been reduced in this office and added to the plot prepared by Mr. Noble. A copy of these curves is appended which sufficiently explains itself.

The difficulty of holding the briquette in the clamps with rubber without crushing them was mentioned by Mr. Noble. A number of experiments were made in which the briquettes were set in the clamps with plaster of Paris. The experiments were conducted by Mr. Ripley. The briquettes that were broken in this way did not show a higher average strength than those that were broken in the ordinary manner, yet Mr. Ripley thinks that less pressure was required to hold them in the clamps.

J J 4.

IMPROVEMENT OF CHEBOYGAN HARBOR, MICHIGAN.

The present project for the improvement of this harbor was adopted in 1871, the object being to afford a channel from the original mouth of the river, 200 feet wide and of not less than 14 feet depth, which was modified in August, 1882, to include the deepening of the basin opposite the steamboat landing and the entire channel extending out to the 15-foot curve in the Straits of Mackinac, 200 feet wide and to a full depth of 15 feet.

Under the appropriation of August 2, 1882, of \$10,000, contract was entered into with Messrs. Carkin, Stickney & Cram, dated September 12, 1882, to do the dredging required for 19 cents per cubic yard, scow measurement.

They commenced work October 19, 1882, and continued to December 6, removing 19,095 cubic yards of clay, some sand and saw-dust, when operations were suspended for the season.

Dredging was resumed April 14, 1883, and continued to June 26, removing 28,000 cubic yards, when the funds available from the appropriation became exhausted.

The total number of cubic yards of excavation under Messrs. Carkin, Stickney & Cram's contract were therefore 47,095, of which 8,030 cubic yards were taken from the 50-foot channel made the previous season, which had filled with sand and saw-dust, and therefore required dredging.

The result of the operations during the past fiscal year may be described as follows:

A uniform depth of 15 feet of water was made in the winding basin opposite the steamboat landing and a width of 200 feet down-stream to the slip between McArthur, Smith & Co.'s and the railroad dock, thence to a channel 1,600 feet long and 110 feet wide, and finally a 90-foot cut on the axis or range line out to the 15-foot curve in the Straits of Mackinac.

The original estimate for this work was \$395,000.

Amount thus far appropriated.....	\$113,000 00
Amount of repayment for fuel	3 00
Total	113,003 00
Amount expended	112,981 96

It will be seen from the foregoing that if the improvement be completed according to the existing project, the cost will be less than half the amount of the original estimate, under which Congress authorized its commencement.

The work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich., and the nearest light-house is at Cheboygan.

The reasons for undertaking this improvement and pushing it forward to completion have been stated in each annual report for years past, and it is not deemed necessary to now repeat them, but merely to say that the construction of railroads in that direction, one (the Mackinaw extension of the Michigan Central) being now in full operation to Cheboygan and beyond, has increased the importance of the point even more rapidly than was anticipated.

Money statement.

July 1, 1882, amount available.....	\$269 42
Amount received from sale of fuel	3 00
Amount appropriated by act passed August 2, 1882	10,000 00
	<hr/> 10,272 42
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$10,031 40
July 1, 1883, outstanding liabilities	120 00
	<hr/> 10,151 40
July 1, 1883, amount available.....	121 02
	<hr/>
Amount (estimated) required for completion of existing project	50,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	26,000 00

Abstract of bids for dredging, improving harbor at Cheboygan, Mich., received and opened by Maj. F. Harwood, Corps of Engineers, on September 12, 1882, in accordance with advertisement dated August 21, 1882.

No.	Names and addresses of bidders.	Price, acow measur.
		<i>Per cu. yd.</i>
1	Carkin, Stickney & Cram, East Saginaw, Mich	\$0 19
2	Charles S. Barker, Sault Ste. Marie, Mich	20
3	Thomas M. Hubbell, Saginaw, Mich.....	25
4	Henry Starke, Milwaukee, Wis	30
5	John Hickler, Buffalo, N. Y.....	40

Contract awarded to Carkin, Stickney & Cram.

COMMERCIAL STATISTICS FOR THE HARBOR OF CHEBOYGAN, MICHIGAN, FOR THE
FISCAL YEAR ENDING JUNE, 30, 1883.

CHEBOYGAN, MICH., July 2, 1883.

DEAR SIR: In compliance with your request I take pleasure in handing you the inclosed statement in regard to the statistics of this port, so far as I am able to arrive at facts. I have no record of exports from this port, the manifests being forwarded to Grand Haven.

The statement of entrances and clearances do not by any means show the number of craft entering the harbor. I have taken some trouble to examine the files of the Northern Tribune, and from its marine column I find that the lines of steamers running from Detroit to Saint Ignace, viz, City of Cleveland, Atlantic, Flora, Pearl, Keweenaw—

	Times.	Tonnage.
Called in, bound up, a total of.....	162	137,454
Called in, bound down, a total of.....	162	137,454
Occasional steamers.....	37	22,702
	<hr/> 351	<hr/> 297,610

None of these appear on the records of the custom-house, as they did not enter or clear from this port. If they had entered and cleared each time it would have showed as follows:

Entrances, 351; tonnage, 297,610. Clearances, 351; tonnage, 297,610.

In addition to this there are a large number of vessels that take grain to Buffalo, and from there clear light to Chicago and call in at this port, load lumber, and proceed on their through clearance.

Hoping the information desired may be derived from what I have given you, I remain, respectfully, yours,

C. S. RAMSEY,
Deputy Collector.

F. U. FARQUHAR,
Major of Engineers.

1852 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Statement of vessels entered and cleared during the fiscal year ending June 30, 1883.

Character of vessels.	Entries.		Clearances.		Reporting boats from Condemned Lake Michigan ports.	
	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.
Steam vessels	232	54,264	236	57,052	33	11,400
Sail vessels	209	61,399	216	62,491	64	12,300
Raft and craft not registered*						
Total	441	117,663	452	119,543	147	23,700

* No record.

Revenue collected	\$6,519 22
Sources from which collected:	
Duties	3,889 14
Marine-hospital collections	214 06
Tonnage tax	672 92
Inspection of steamboats	415 15
Entrances and clearances	514 54
From all other sources	812 90
Total	6,519 22

IMPORTS.

Immigrants' effects	\$3,547 25
Live stock	21,643 75
Fish	6,594 74
Manufactured articles	102 50
Butter	1,266 36
Total	33,154 00

J J 5.

IMPROVEMENT OF ALPENA HARBOR, AT THUNDER BAY, MICHIGAN.

The project for the improvement of this harbor was adopted in 1876, the object being to afford a channel of entrance of navigable width and of not less than 13 feet in depth, subsequently modified with a view to making a channel of 14 feet in depth.

Under the appropriation of \$13,000 made by act of Congress, dated August 2, 1882, contract was entered into with Mr. Charles S. Barker, of Sault Ste. Marie, Mich., dated September 12, 1882, to do the dredging required for 20 cents per cubic yard, scow measurement.

Work was commenced October 3, 1882, and continued until November 25, when, on account of sudden cold weather, it was closed for the season; 6,737 cubic yards of material were removed, consisting principally of sand, some hard-pan, and water-soaked slabs.

On the 9th of May, 1883, dredging was resumed and continued to the end of the fiscal year, 10,162 cubic yards being removed, giving a total of 16,899 cubic yards under Mr. Barker's contract during the past fiscal year.

On account of severe weather, high water, and other drawbacks the work was not completed at the time specified in the contract; the lat-

work was therefore extended to December 1, 1883, and dredging will be continued during the present season.

At this time it seems probable that the amount already appropriated will be sufficient to complete the improvement according to the existing project. For this reason no estimate is submitted at this time for the fiscal year 1884-'85. Should the operations now going on develop a necessity for further appropriations a supplementary report, with estimate, will be forwarded.

This work is located in the collection district of Port Huron, Mich. The nearest port of entry is Port Huron, Mich., and the nearest light-house is at Thunder Bay River.

The commerce directly benefited by the work is that to and from Thunder Bay River, at the mouth of which is situated the important and growing town of Alpena.

Money statement.

July 1, 1882, amount available.....	\$109 52
Amount appropriated by act passed August 2, 1882	15,000 00
	15,109 52
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$2,844 74
July 1, 1883, outstanding liabilities	1,597 20
	4,441 94
July 1, 1883, amount available.....	10,667 58

Abstract of bids for dredging, improving harbor at Thunder Bay, Michigan, received and opened by Maj. F. Harwood, Corps of Engineers, on September 12, 1882, in accordance with advertisement dated August 21, 1882.

No.	Names of bidders and residences.	Price, cu yd. measure.
		Per cu. yd.
1	Charles S. Barker, Sault Ste. Marie, Mich	\$0 20
2	Thomas M. Hubbell, Saginaw, Mich	23
3	Carlin, Stokney & Cram, East Saginaw, Mich.....	24
4	Henry Starke, Milwaukee, Wis.....	28

Contract awarded to Charles S. Barker.

COMMERCIAL STATISTICS FOR THE PORT OF ALPENA, THUNDER BAY, MICHIGAN, FOR THE FISCAL YEAR ENDING JUNE 30, 1883.

ALPENA, July 3, 1883.

DEAR SIR: At your request I herewith forward to you a statement, as near as I can estimate, of the shipping of this port for the fiscal year ending June 30, 1883. As I stated in my letter to you several days since, it is impossible for me to give an accurate statement of the values of either imports or exports, as I have no means of knowing, neither of the draughts of steamers and sail and barges, so I leave those blank; but to give a more general idea of the business of this port I will state that the steamer City of Cleveland enters and departs from this port twice a week, without report or clearance, and the steamer Keweenaw once a week, also the steamers Flora and Atlantic same; also the steamers Aurundal and Metropolis three times a week each to and from Bay City. Also many vessels that take clearances from other ports for Chicago, that come and load here and do not report or clear from this port. So it is quite impossible to give a very accurate statement of the business of this port.

Yours, respectfully,

G. S. LESTER,
Deputy Collector.

Maj. F. U. FARQUHAR.

1854 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Statement of vessels entered and cleared during fiscal year ending June 30, 1883.

Character of vessels.	Entries.		Clearances.		Revenue collected.
	No.	Tonnage.	No.	Tonnage.	
Steam vessels	202	85, 300	202	85, 300	.....
Sail vessels	455	96, 450	455	96, 450	.....
Rafts and craft not registered	None.				.....
Total	657	181, 750	657	181, 750	\$900 53

J J 6.

IMPROVING HARBOR AND RIVER AT AU SABLE, MICHIGAN.

At the beginning of the fiscal year ending June 30, 1883, the lower portion of the United States pile and edging revetment built on the northeasterly boundary of the river channel in 1881, and called Section IV, had become undermined, the slab and edging filling had settled below the water line, and the piles were beginning to lean over into the channel on account of insufficient penetration. The repairs of this section of work were made in July, 1882, at an expense of \$31.55.

One hundred and fifty linear feet, being the outer end of the revetment extension of the south United States pier, was wrecked in the fall of the season of 1882; but as Mr. Gram had discontinued the construction of his lumber dock, which formed the backing and filling behind the United States revetment (and which Mr. Gram had furnished at his own expense) it was not deemed advisable to renew the wrecked portion of the Government work at this time.

It was expected that the extension of the south United States pier into deep water would guide the swift current of the river in such a manner that the channel dredged in May, 1882, giving 10 feet depth of water, would receive the benefit of a scour and thus remain intact. Such was not the result, however, as was shown by an examination made within six weeks after the dredge cut was completed. The bar at the mouth of the river extends from the end of the north or lighthouse pier obliquely across the axis of the river channel to the end of and slightly beyond the south pier extension, its outer face being a steep incline to deep water in Lake Huron.

An examination made under the direction of Maj. F. U. Farquhar, May 4 and 5, 1883, established the fact that no scouring effect can be produced by the extension of the south pier alone; that the bar is continually and gradually increasing in size, diverting the river current to the northward, and that in order to maintain a navigable channel entrance dredging will be required not only once in a season, but in every month of the season of navigation, unless the north United States pier is extended in a like inexpensive manner to the full length of the south pier.

Under the direction of Major Farquhar, estimates for pier extensions were made in June, 1883, as follows:

North pier:

3 cribs 80 by 20 by 12 feet deep, with 5 feet superstructure.
 3 cribs 80 by 20 by 14 feet deep, with 5 feet superstructure.
 3 cribs 80 by 22 by 16 feet deep, with 5 feet superstructure.
 3 cribs 80 by 24 by 18 feet deep, with 5 feet superstructure.
 1 crib 30 by 30 by 18 feet deep, with 6 feet superstructure.
 990 linear feet, north pier extension.

South pier:

cribs 80 by 22 by 16 feet deep, with 5 feet superstructure.

cribs 80 by 24 by 18 feet deep, with 5 feet superstructure.

crib 30 by 30 by 18 feet deep, with 6 feet superstructure.

1 linear foot, south pier extension.

Total, 1,460 linear feet of crib-pier construction, at an estimated cost of \$80,000, or \$1.80 per linear foot.

It is not apparent that the expensive crib construction will be any more efficacious in confining the river current so as to maintain a channel entrance of navigable depth than a pile and edging pier would be; and at this locality, where pile piers are built out from the shore of Lake Huron, used for lumber docks, and withstand the heaviest seas, where piers and edgings can be obtained in abundance at a nominal expense, the less expensive pile-pier construction should be adopted in extension of the piers, with the exception, perhaps, of the terminal crib, on to which the light-house should be moved. If the north pier can be extended the required length in one season, provision should be made for sufficient funds to remove the bar entirely and dredge a channel the full width between the piers and to 12 feet clear depth of water, in order to prevent the shifting of the old or formation of a new bar by the action of the river current. To do this would require the removal of about 18,000 cubic yards of material, at a cost estimated at 33½ cents per cubic yard, or a total of \$6,000.

The project of confining the upper reaches of the river between nearly parallel lines of pier has proved entirely satisfactory, the channel from the Oscoda or State road bridge to the mouth of the river having deepened to nearly 10 feet without the aid of a dredge, and solely by an increased scouring action of the current resulting from the confinement of the river bed between the piers.

The so-called Backus Revetment, having been abandoned to the use of the Government by common consent of property owners along the river fronts, was included in the original project, the northeasterly revetment, section 3, being essentially an extension of the Backus Revetment. The latter has threatened to succumb under the force of the increased current and greater depth of water along its channel front, so that it became necessary to drive a row of piles in front of the places where the structure appeared to be the weakest. At the upper end, where originally drop-gates were used for the admission of logs to the store-boom in the rear of the revetment, a large section was broken through and one of the gates carried away. A great body of water is thus diverted from the river channel into the boom, raising the water level therein, and as the small log chutes at the lower end of the United States Revetment, section 4, are not adequate for the prompt discharge of the surplus, the United States Revetment, as well as the old Backus Revetment, is threatened destruction by being gradually undermined. The former has been repaired once, as stated in the beginning of this report, but the latter is still in a precarious condition.

To complete, therefore, permanently the upper river improvement, it will be necessary to repair and reinforce the Backus Revetment, including the construction of a log chute at its upper end of sufficient width to admit a dredge into the boom when necessary. The work has been estimated to cost \$4,500, and was recommended in the annual report for the fiscal year ending June 30, 1882.

Nothing short of the work herein proposed will accomplish the object. Its estimated cost is \$32,121.60. It would be advisable to appropriate the entire amount of the estimate at one time, and it ought not to extend beyond two appropriations. In the latter case, to insure satisfactory results, the sum appropriated to begin the work should be at least \$20,000.

1856 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Attention is respectfully invited to the appended report of B. H. Muehle, assistant engineer.

This work is situated in the Huron collection district, Michigan, about 14 miles north of Tawas light-house. The nearest port of entry is Port Huron, Mich.

The original project for the improvement was adopted in 1866, and modified in 1879, the object being to afford a channel of 10 feet in depth with a width of 100 feet. The project now suggested is to increase the depth to 12 feet, the width remaining the same as before.

The original estimate of the cost of the work was \$82,892.72, and the appropriations to the present time amount to \$107,970, of which \$4,900.55 remain unexpended, making the cost thus far \$103,069.45. This last amount may be slightly in excess of the actual cost, since it is possible that some of the balances of appropriations may have been returned to the Treasury.

The cost of the work, however, has exceeded the estimates, due entirely to the physical characteristics of the locality, which are of such a nature as to render the duration of any improvement very limited. In 1868 the officer then in charge of the work, and who made the original estimate, estimated that an annual appropriation of \$6,000 would be required to keep the channel open by dredging, and his successor in 1870, with added experience, estimated that the cost of this annual dredging would be \$3,000. This has been confirmed by the knowledge gained during the subsequent years.

The project now submitted is not expected to *permanently* improve the entrance channel to the harbor, but merely to secure an available channel for a sufficient length of time to justify the cost.

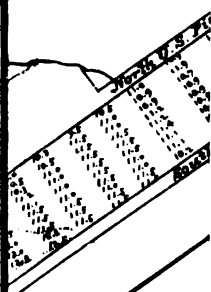
I submit estimates for pile and edging pier extension for the improvement of the river inside and for dredging between the extended piers.

ESTIMATE OF COST OF PILE AND EDGING PIER EXTENSION AT AU SABLE RIVER HARBOR, MICHIGAN—NORTH PIER, 990 LINEAR FEET; SOUTH PIER, 470 LINEAR FEET.

NORTH PIER.	
384 oak or Norway piles, 30 feet long, at \$4	\$1,536 00
384 oak or Norway piles, 35 feet long, at \$5	1,920 00
134 oak or Norway piles, 40 feet long, at \$6	792 00
62,080 feet, B. M., pine timber, 12 by 12 inches, at \$25	2,058 00
24,000 feet, B. M., oak timber, 8 by 12 and 8 by 6 inches, at \$35	840 00
18,900 feet, B. M., pine plank, 3 by 12 inches, at \$20	378 00
13,350 pounds screw and washer bolts, 1½ inch, at 8 cents	1,068 00
2,160 pounds wrought iron 7-inch spikes, at 5 cents	108 00
2,546 cords slabs and edgings, at 50 cents	1,273 00
280 cords stone, at \$10	2,800 00
	12,767 00
Add 10 per cent. for contingencies	1,276 70
	14,043 70
SOUTH PIER.	
352 oak or Norway piles, 35 feet long, at \$5	\$1,760 00
134 oak or Norway piles, 40 feet long, at \$6	792 00
40,920 feet, B. M., pine timber, 12 by 12 inches, at \$25	1,023 00
12,000 feet, B. M., oak timber, 8 by 12 inches and 6 by 8 inches, at \$35	420 00
9,600 feet, B. M., pine plank, 3 by 12 inches, at \$20	192 00
6,800 pounds screw and washer bolts, 1½ inches, at 8 cents	544 00
1,200 pounds wrought iron 7-inch spikes, at 5 cents	60 00
1,316 cords slabs and edgings, at 50 cents	658 00
144 cords stone, at \$10	1,440 00
	6,899 00
Add 10 per cent. for contingencies	689 90
	7,577 90

H

WATER DOCK



John C. Gram
Saw Mill



RECAPITULATION.

Estimated cost of north pier	\$14,043 70
Estimated cost of south pier	7,577 90
Total cost of pier extension	21,621 60
Estimated cost of the river improvement	4,500 00
Estimated cost of dredging	6,000 00
Total estimated cost of the project	32,121 60

Money statement.

July 1, 1882, amount available	\$60 95
Amount appropriated by act passed August 2, 1882	5,000 00
	5,060 95
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	160 40
July 1, 1883, amount available	4,900 55
Amount (estimated) required for completion of existing project	32,121 60
Amount that can be profitably expended in fiscal year ending June 30, 1885	32,121 60

REPORT OF MR. B. H. MUEHLE, ASSISTANT ENGINEER.

AU SABLE, MICH., May 7, 1883.

MAJOR: In obedience to your instructions to make an examination and report the condition of the Au Sable river and harbor improvements, I have visited Au Sable, have taken soundings in the river, from the State Road Bridge to the mouth and over the outer bar, and now have the honor to report the following:

The plank beam wall which confines the river along the easterly or Au Sable village front (built in 1879, and called sections 1 and 2 in former reports) is in good condition. The plank beam has settled somewhat, but rests upon a gravel foundation in a sufficient number of places to prevent its further settling; its upper surface is within 1 to 2 feet of the timber connecting the tops of the two rows of piles, between which it is held in upright position.

The pile and edging revetment built on the opposite side of the river (sections 3 and 4) is also in excellent preservation, the slab and edging filling having settled but very little, with the exception of the lower end near the chute constructed for the accommodation of J. E. Potts & Co.'s saw-mill, where the filling has settled to near the water's edge, on account of a strong undermining current produced by the insufficient discharge of the water from Potts' boom in the rear, for which the aforesaid chute furnishes the only outlet.

The river channel between the beam wall and revetment has been scoured out by the current to a depth of clear 9 feet, with many places showing 10 feet and over, and some of these to gravel bottom. Thus the object sought has been attained at this locality, but at the expense of the safety of the Backus Revetment, a dilapidated and abandoned pile and edging structure extending from the State Road Bridge to the initial point of section 3, and of which the latter is an extension. The river, emerging from underneath the said bridge with a swift current, has broken through the weakest portion of the Backus Revetment near its upper end, a length of about 150 feet, and feeds the booms and log channels east of it with a desirable amount of water, but also with an unwelcome quantity of sand. The openings at the lower end of the United States Revetment being inadequate for prompt discharge, the water in the booms is raised, and seeks to make for itself an outlet at the weakest points of the east revetment. Thus the Backus Revetment was gradually undermined to an alarming degree, and as it formed part of the original project of confining the river current between narrow boundaries from the State Road Bridge to Potts' dock, it became necessary to strengthen it in order to prevent its eventual entire destruction. Accordingly a row of piles was driven along its channel front with sufficient penetration to keep the old structure and its slab filling in position. These piles are still in place, and have answered their purpose, but they project 10 to 15 feet above the water surface, and are not secured to the revetment or connected with each other. A waling piece at the water's edge, and a cap timber drift-bolted to the tops of the piles, cut off at a height of 5 feet above low water, together with some suitable connection with

the old work, would be sufficient to complete the repairs so well begun. The parties owning the boom immediately behind the revetment inform me that they are willing to provide and put in a filling of slabs and edgings or brush to the proper height at their expense. The upper end of the Backus Revetment, below the break, through which logs are now passed into the booms, was secured by a pile and timber bulkhead, which I found in good condition. From this point to the bank on a line at an angle of about 45 degrees, a distance of 117 feet, the Revetment should be extended with a chute similar in construction to the one at Potts' dock. By this means no greater amount of water could enter the booms above than the openings below are able to discharge, and though the current required or desirable to move the logs in the booms may be considerably reduced, yet the further undermining of any portion of the ~~ear~~ revetment will be prevented and the original project completed, with as good result in making and maintaining a good navigable channel between the State Road Bridge and the mouth of the river as has been or could be expected.

But the benefit to navigation derived from this part of the improvement is entirely neutralized by the difficulty of entering the mouth of the river. A bar of sand has formed across the channel entrance, which cannot be permanently removed by dredging; its crest is 5 feet below low water. The soundings taken by me on May 5, 1882, fail to reveal the slightest trace of the dredge cut 75 feet wide and 12 feet deep (3,000 cubic yards), made during the month of May, 1882, and I am informed that it filled up soon after it was made. If this bar is not removed by the Government, the mill-owners will dredge a cut through it at their own expense this season for temporary relief. The outer face of the bar is a steep incline toward deep water, say 16 feet depth, and it is the general opinion of the parties most interested in shipping at this harbor that if the north pier was extended to deep water parallel to and about 100 feet distant from the south pier, with a timber and stone crib at its outer end, on which the light-house should be placed, the removal of the bar would be of permanent benefit to navigation. As Mr. John C. Gram extended a slab pier behind a pile revetment on the south side of the channel entrance at his expense, so it is believed would Mr. J. E. Potts provide a filling for a similar pile pier on the north side if the Government would build the crib for the light-house and connect it with the present terminus of the north pier by a pile revetment. If while this filling is being placed the present sand-bar is entirely removed by dredging, it is probable that the channel entrance will remain open, for vessels drawing as much as the inner harbor will allow, for the period of six years and longer.

There are twenty vessels of various sizes loaded here every week, averaging 9,000,000 feet of lumber, and as most of the lumber docks are on the shore of the lake, and the vessels while being loaded are exposed to storms from northeast and southeast, an easily accessible inner harbor would be of great benefit to the shipping. On the approach of a storm, partially loaded vessels are now obliged to seek shelter in Tawas Bay, a run of 15 miles from here, and much damage to lives and property would be prevented if such vessels could be towed into the river, where even now there is plenty of room and sufficient depth of water for all vessels which may be loading outside at the same time.

The price of timber has considerably advanced since last year; white pine, common lengths, costs \$14 to \$18 per 1,000 feet, B. M.; Norway pine, from \$11 to \$13; pike, about \$2 each; pile-driving inside the river \$1.50, and outside \$1.75 to \$2 per pile driven. There is a quantity of iron screw and drift bolts stored in the warehouse near the lower end of the beam wall, which might be used in construction or repair work.

I am, major, very respectfully, your obedient servant,

B. H. MUEHLE,
Assistant Engineer.

Maj. F. U. FARQUHAR,
Corps of Engineers, U. S. A.

J J 7.

IMPROVEMENT OF SAGINAW RIVER, MICHIGAN.

At the beginning of the fiscal year ending June 30, 1883, repairs and re-enforcement of the upper section of the Carrollton Plank Beam Training Wall were in progress and completed during the months of July and August, 1882.

Maj. F. Harwood's proposition for the expenditure of the \$125,000 appropriated by act of Congress dated August 2, 1882, was based upon

The survey of 1881, and the projects of improvement given in his report dated November 29, 1881, all of which were referred to a Board of Engineer Officers created by Special Orders No. 82, Office of the Chief of Engineers, and composed of Maj. H. M. Robert, Maj. F. U. Farquhar, and Maj. D. P. Heap.

The Board met at East Saginaw on the 13th of September, 1882, and at Detroit on the 18th of October, and recommended dredging the Saginaw River from the head of navigation to the Portsmouth Bridge at Bay City to a depth of twelve feet, not less than 200 feet wide, estimated 270,000 cubic yards; also in front of Bay City to a depth of 14 feet, estimated 80,000 cubic yards, and across the bar at the mouth of the river to a depth of 14 feet, estimated at 240,000 cubic yards; and the construction of two cross-dams at Carrollton Bar and Oneida Channel, respectively. The total estimated cost of these projects is \$446,000. In conformity with the conclusions of the Board, Maj. F. U. Farquhar, Corps of Engineers, United States Army, who had, on September 16, 1882, relieved Major Harwood, submitted his proposition for the expenditure of the appropriation of August 2, 1882, of "which \$60,000 were to be used opposite Bay City and for deepening the channel from the river into the bay, and \$65,000 for improving the river above Bay City," as follows: To construct the cross-dams at Carrollton Bar and Oneida Channel, estimated cost \$6,000; to commence dredging above Bay City at Willow Island, and to work up-stream, removing bars, as far as the funds available (\$58,000) shall admit of; to remove the bar in front of Bay City, 80,000 cubic yards, and, with the balance of appropriation, to commence the dredging of the channel through the bar at the mouth of the river. These recommendations having been approved, bids for dredging in three separate locations were invited January 17 and opened February 14, 1883.

On February 14, 1883, contract was entered into with Mr. Castle Sutherland for dredging in front of Bay City for 25 cents per cubic yard, scow measurement; also, on February 16, with Messrs. Carkin, Stickney, and Cram, for the dredging above Bay City for 37½ cents per cubic yard, scow measurement. The lowest bidder for the work of dredging the channel across the bar at the mouth of the river, Mr. David W. McConnell (bidding 30 cents), failed to enter into contract; hence the next lowest bidder, Mr. Castle Sutherland, was awarded the contract March 27, 1883, at 60 cents per cubic yard, scow measurement.

On June 1, 1883, dredging operations were begun under the three contracts above mentioned, and during the month of June, the last of the fiscal year, the following quantities of materials had been removed:

	Cubic yards.
1. Above Bay City, by Carkin, Stickney & Cram	3,913
2. Front of Bay City, by Castle Sutherland.....	4,650½
3. Mouth of river, by Castle Sutherland.....	5,597

The amount expended during the fiscal year ending June 30, 1883, is \$11,233.54, and was applied to the completion of the repairs and reinforcement of the upper section of the plank beam training-wall at Carrollton Bar, some minor examinations and surveys, to obtain information for the Board of Engineer Officers, the completion of the maps of the survey of 1881, and to dredging operations under contract at Willow Island, at Bay City, and at the mouth of the river respectively.

The original project for the improvement of this river was adopted in 1874 and modified in 1878, the object being to afford a clear depth of not less than 10 feet over the bars in the river, of which there were four—the Carrollton, Zilwaukee, New York Works, and Willow Island Bars.

1860 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Under the several appropriations, amounting on July 1, 1881, to \$89,862.88, works of improvement were carried on at those localities in the order named with the exception of the last—Willow Island—which was not reached on account of the insufficiency of the appropriation. At the time the resurvey of the upper river was ordered to be made, having in view a project to obtain and secure a navigable channel of not less than 12 feet depth of water from the head of navigation to Bay City, the original and modified project, to secure and maintain 10 feet depth, was not completed. The condition of the channel at the several localities was as follows:

At Carrollton Bar, the contraction of the width of the channel to 300 feet between the revetment pier and its extension of the east and the plank beam training-wall on the west side had produced a more satisfactory scouring action of the current than was intended or required for the purpose, cutting out the channel at the upper end of this canal from an original 6 to 8 feet to a depth of 15 to 16 feet, threatening the undermining of, and necessitating the repairs and re-enforcement of the upper section (500 linear feet) of the plank beam training-wall. The sand thus removed by the action of the current from the upper two-thirds portion of the Carrollton Channel found a place of deposit at the lower end opposite Charles Grant and Company's saw-mill, where the cross-sectional area of the river is suddenly enlarged to three times that of the canal. The extension down-stream of the revetment on the east and the beam-wall on the west side was contemplated under the old project, but was abandoned in the last one, now in force. Not more than 8 feet available depth of water has prevailed at this point since the last dredging was done in August, 1881.

At Zilwaukee Bar there is a good channel of 10 feet available depth of water close to the United States wing-dam, but, as pilots are not sufficiently acquainted with the locality of this channel, they frequently strike bottom in the middle of the river, where the best water used to be. No dredging has been done here since October and November, 1879, and but little would be required to straighten and widen the 10-foot channel.

At New York Works the only dredging done by Government aid was in March and April, 1880, with a balance of the appropriation of 1879 (\$8,000); a shoal projecting from the lower end of Crow Island into the channel was removed and 10 feet depth of water made across the bar at the end of Hamilton & McClure's lumber dock. This cut has since partially filled up, and no more than 9 feet available depth of water can be relied on along the entire front of the New York Works lumber docks. This shoal area is the result of the conjunction of the Zilwaukee or main channel with the Oneida Channel, and consequent widening of the river at the foot of Crow Island.

At Willow Island no money from Government appropriations has been expended prior to June 1, 1883, though projects for the improvement of the channels adjacent to it, so as to afford an available depth of 10 feet, were included in all general projects for the improvement of the river; see Major Harwood's letter to the Chief of Engineers, dated March 27, 1879, and Annual Reports of 1879, 1880, and 1881.

The island, about 800 feet long and 150 feet wide in the middle, is very low, being half under water when the river rises to 1 foot above standard low water, and entirely submerged when the gauge reads +3 feet. The best channel for navigation is on the east side of the island, where a depth of 10 feet is found with a width varying from 50 to 100 feet. The up-stream portion of this east channel is very narrow, and its

entrance blocked up by accretions of sand brought down by the current at a point about 600 feet above the head of the island. This channel is now being dredged, under contract with Messrs. Carlin, Stickney & Cram, to a clear depth of 12 feet by 200 feet wide. The west channel, on account of its greater width and a uniform available depth of 8 feet, was used by rafts and light-draught river steamers, until the owners of the adjacent saw-mill appropriated nearly two-thirds of its width for a log-boom; it is now of but little use for navigation.

The dredging now in progress in front of Bay City and at the mouth of the river is the initiatory operation in carrying out the approved project of affording 14 feet clear depth of water at the localities named. The estimate of quantities requiring removal was based on the survey made in January and February, 1881. The bench-mark on the steps of the old light-house at the mouth of the river having been destroyed during the removal of the building, a temporary water-gauge was secured to the new light-house and range beacon for use during the survey (reading +0.5 when put up), the zero of which gauge has since then been frequently compared with the up-river gauges, notably, by simultaneous readings during the month of October, 1882, under the direction of Maj. F. U. Farquhar, Corps of Engineers, United States Army, which established the fact that the datum level of the mouth of the river differs but a trifle from those of upper-river stations, and that the error or difference is on the right side, *i. e.*, increased benefit to navigation. A compilation of the simultaneous gauge readings by the dredging inspectors during the present season will be specially valuable in connection with the permanent establishment of datum level at suitable distances apart throughout the entire length of the river.

All material dredged under the present contracts is required to be deposited on shore, no less than 20 feet from the river bank, or towed out and dumped in Saginaw Bay; the care of the material removed and the means of placing it upon the river bank is left entirely to the contractor, who takes all responsibility for risk and expense in so disposing of it. The immediate consequence of this clause of the contract is a high price demanded for dredging, even by the lowest bidder, especially on upper-river work. The enormous quantity of material to be disposed of in the prosecution of the present project to make 12 feet available depth of water from Saginaw City to Bay City must be placed on the river bank; and, in order to get the work of excavation done at a reasonably low figure, it seems advisable to find a way of dividing the responsibility of locating a place of deposit for the material between the contractors and the United States Government, or to have dumping stations established by the latter authority alone.

Money statement.

July 1, 1882, amount available.....	\$2,517 23
Amount received from sale of fuel	10 50
Amount appropriated by act passed August 2, 1882.....	125,000 00
	<hr/>
	127,527 73
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$4,030 35
July 1, 1883, outstanding liabilities.....	7,203 19
	<hr/>
	11,233 54
July 1, 1883, amount available.....	116,294 19
	<hr/>
Amount (estimated) required for completion of existing project.....	421,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	200,000 00

1862 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of bids for dredging bar at mouth of Saginaw River, Michigan, received and opened by Maj. F. U. Farquhar, Corps of Engineers, on February 14, 1883, in accordance with advertisement dated January 17, 1883.

No.	Names and addresses of bidders.	Price, per measure.
		<i>Per cu. yd.</i>
1	David W. McConnell, Buffalo, N. Y.	\$0 28
2	Castle Sutherland, East Saginaw, Mich.	60
3	George Talbot, Buffalo, N. Y.	65
4	Carkin, Stickney & Cram, East Saginaw, Mich.	74
5	James Rooney, Toledo, Ohio	77
6	Thomas M. Hubbell, Saginaw, Mich.	79
7	Green's Dredging Company, Chicago, Ill.	83
8	Chicago Dredging and Dock Company, Chicago, Ill.	84
9	Christian Schwarz, Fort Howard, Wis.	84
10	Harry Fox & Co. Chicago, Ill.	85
11	Charles S. Barker, Sault Ste. Marie, Mich.	89
12	Dodge & Petrie, Little Falls, N. Y.	95
13	Truman & Cooper, Manitowoc, Wis.	98

David W. McConnell, the lowest bidder in the last case, failed to enter into contract, and the contract was finally awarded to Castle Sutherland, the next lowest bidder.

Abstract of bids for dredging Saginaw River, Michigan, in front of Bay City, received and opened by Maj. F. U. Farquhar, Corps of Engineers, on February 14, 1883, in accordance with advertisement dated January 17, 1883.

No.	Names and addresses of bidders.	Price, per measure.
		<i>Per cu. yd.</i>
1	Castle Sutherland, East Saginaw, Mich.	\$0 25
2	D. W. McConnell, Buffalo, N. Y.	25
3	Thomas M. Hubbell, Saginaw, Mich.	37
4	Carkin, Stickney & Cram, East Saginaw, Mich.	37
5	Harry Fox & Co., Chicago, Ill.	38
6	Wm. Richardson, Buffalo, N. Y.	40
7	Jas. Rooney, Toledo, Ohio	40
8	Chicago Dredging and Dock Company, Chicago, Ill.	40
9	Green's Dredging Company, Chicago, Ill.	41
10	Christian Schwarz, Fort Howard, Wis.	42
11	Charles S. Barker, Sault Ste. Marie, Mich.	45
12	Truman & Cooper, Manitowoc, Wis.	46
13	Dodge & Petrie, Little Falls, N. Y.	48

Contract awarded to Castle Sutherland.

Abstract of bids for dredging Saginaw River, Michigan, above Bay City, received and opened by Maj. F. U. Farquhar, Corps of Engineers, on February 14, 1883, in accordance with advertisement dated January 17, 1883.

No.	Names and addresses of bidders.	Price, per measure.
		<i>Per cu. yd.</i>
1	Carkin, Stickney & Cram, East Saginaw, Mich.	\$0 37
2	Thomas M. Hubbell, Saginaw, Mich.	39
3	David W. McConnell, Buffalo, N. Y.	40
4	Harry Fox & Company, Chicago, Ill.	40
5	Chicago Dredging & Dock Company, Chicago, Ill.	41
6	Green's Dredging Company, Chicago, Ill.	42
7	Christian Schwarz, Fort Howard, Wis.	43
8	Charles S. Barker, Sault Ste. Marie, Mich.	49
9	Norris G. Dodge, Little Falls, N. Y.	50
10	Truman & Cooper, Manitowoc, Wis.	50

Contract awarded to Carkin, Stickney & Cram.

LETTER OF THE CHIEF OF ENGINEERS, SUBMITTING REPORT OF
BOARD OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., November 7, 1882.

SIR: The subject of the improvement of Saginaw River, Michigan, upon a more extended scale than has heretofore been attempted was brought to the notice of the House Committee on Commerce in a report transmitted February 7 last to that committee, at the request of the chairman, which was referred February 2 to this office for reply, and doubtless led to the increased appropriation of August 2, 1882, for the improvement.

Before deciding upon the application of this appropriation of \$125,000, it was deemed advisable, with your sanction, to convene a Board of Engineer Officers to consider and report a plan of improvement better suited to the present wants of the commerce of the river.

I now have the honor to submit for your consideration the report of this Board, and, concurring in its views, as this may be considered a new work, to recommend the adoption of the recommendations therein contained. If this be approved, the officer in charge of the work will be called upon to submit a project for the application of the appropriation of August 2, 1882, in accordance therewith.

Very respectfully, your obedient servant,

H. G. WRIGHT,
*Chief of Engineers,
Brig. and Bvt. Maj. Gen.*

Hon. ROBERT T. LINCOLN,
Secretary of War.

[First indorsement.]

Approved.

By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

WAR DEPARTMENT,
December 18, 1882.

REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., October 19, 1882.

GENERAL: The Board of Engineer Officers constituted by Special Orders No. 82, current series, from Headquarters Corps of Engineers, to consider and report upon the project for the improvement of the Saginaw River, Michigan, met at East Saginaw, Mich., on the 13th September, 1882, with all the members present, and have the honor to submit the following

REPORT.

The Saginaw River is a stream 22 miles long, formed by the junction of the Tittabawassee and Shiawassee rivers. At ordinary stages of water it flows with a gentle current through a marshy district, the fall being about 3 inches to the mile. There is one principal and several minor channels, the former being generally wide and of navigable depth, but obstructed at many points by bars and shoals, with deep water be-

tween. These bars are formed by the sand brought down by freshets, which sand the feeble current during low water is unable to remove.

At the mouth of the river is a bar, the least depth of water on which was about 6 feet before the commencement of any improvement. The 14-foot curve of this bar commences at 4,000 feet from the shore. The distance from this 14-foot curve to the 14-foot curve in Saginaw Bay is 12,000 feet.

The bar is composed of a mixture of hard clay, gravel, and gypsum, and is exceedingly difficult to dig.

The improvement at Saginaw River was commenced in October, 1867, by dredging a channel across the bar above mentioned, 6,800 feet long, 195 feet wide at the bottom, with side slopes of 1 on 2, and to a uniform depth of water of 12 feet below the lowest known stage.

During the years 1867-'68-'69, 107,929 cubic yards material were removed, and the work was considered completed.

In 1872 a survey was made at the mouth of the river, showing a channel 180 feet wide and 12 feet deep.

In 1881, 11,019 cubic yards were removed in order to restore a channel 75 feet wide and 12 feet deep, the channel having gradually shoaled in course of time.

The improvement of the river commenced in 1874. It consisted in removing several sand-bars, mainly at Carrollton, and in building a revetment pier 700 feet long on the east side of the river at Carrollton.

Up to this time \$80,000 had been raised by local taxation and expended in dredging and removing obstructions in the river, but the results had been unsatisfactory.

The original project for this work was completed in 1877 with the exception of the lower bulkhead, and consisted of a timber frame-work 3,780 feet below the bulkhead and 264 feet from the shore. Dredging had been carried on at the same time to complete a channel 90 feet wide and 10 feet deep.

In 1878 the revetment work, including the lower bulkhead, was completed and the channel in front was widened to 100 feet.

The results of these improvements not proving as satisfactory as was anticipated, a new work was projected to fence in the Carrollton Bar by a plank beam training-wall, opposite and parallel to the revetment, and about 200 feet from it. The channel between was deepened to 10 feet, and the revetment was extended 1,000 feet further down.

During the same year all the snags had been cleared from Saginaw City to the mouth, and the wing-dam at the Zilwaukee Bar was commenced and completed; this dam was of similar construction to the one at Carrollton, and was 900 feet long, 6 feet wide, and 6 feet above water.

Dredging was done opposite to East Saginaw in the Carrollton Channel, renewing it to 100 feet width and 10 feet depth; on the Zilwaukee Bar, and at the New York Works; in all, 33,123 cubic yards. All excavated material was placed behind the middle ground below Crow Island, completely filling that area.

The revetment pier at Carrollton Bar, burnt in 1877, was repaired, and constant repairs and refilling of the timber frame-work has been required since.

During 1881 the spread of the Carrollton Bar into the channel at the lower end of the east revetment was removed by aid of a local appropriation.

The annexed map* gives the relative positions of the improvements

* Not printed.

referred to, and of the places where dredging was done in the vicinity of Carrollton.

Appended is a recapitulation of money appropriated and labor performed on the Saginaw River and the bar at its mouth.

At the meeting of the Board the presiding officer submitted the copy of the instructions from the Chief of Engineers, United States Army.

Maj. Franklin Harwood appeared before the Board and laid before it his project for the improvement of the river, together with maps, tracings, and other explanatory matter.

Mr. Muehle, assistant engineer, also was present; he had made the survey of the river, and could answer many important questions of detail. During the session the president of the Board of Trade, the president of the Boom Company, and other gentlemen representing the vessel, logging, milling, and salt interests, were invited to be present, and to give expression as to their views and to the needs of the commerce of the Saginaw Valley.

The following information was obtained: The commerce of the Saginaw Valley is dependent upon two staples, lumber and salt. To them it entirely owes its prosperity, and the improvement of the Saginaw River is wholly designed to facilitate the convenient handling and shipping of these two commodities.

The lumber interest is by far the most important of the two, and the salt interest depends upon it, as the most successful salt-producers are the mill-owners, who can use their waste steam, the sawdust and other refuge from the mills to evaporate the brine, thus reducing the cost of production to a minimum.

The mills in their turn are dependent upon a plentiful and continuous supply of logs, and as logs can only be sent down from the logging camps at irregular intervals during the year, it is necessary to have a number of store-booms conveniently located and easy of access, in which the mill-owners can store their logs, and from which they can draw during the season that the logs are not running.

These store-booms line both sides of the river for nearly its total navigable length. The present head of navigation of the river is at the junction of the Shiawassee and Tittabawassee rivers, 22 miles above the mouth, and it is here that is located the Tittabawassee Boom Company's boom. The logs are floated down the river, put in this boom, sorted out, made up into rafts, and delivered to their respective owners. These rafts are composed generally of five strings, and will average 80 feet wide and 1,800 feet long.

During the summer four rafts are daily sent as far as Zilwaukee, and two all the way to Bay City. These rafts in former days were floated down, and it was then thought an absolute necessity to provide two channels, one for the rafts in shallow water and another for the vessels; but now this is found to be no longer necessary, as, owing to the magnitude of the lumber business, they cannot now put up with the slow method of floating the rafts, but instead use powerful tugs drawing about 6½ feet of water to tow them, and in most cases they are found to be entirely manageable and can be kept out of the way of the vessels, though occasionally when the wind blows strongly across the stream the raft may so swing as to temporarily block the channel.

From the above it will be seen that the logging interest is already well provided for; there is ample water for the rafts and tugs; the store-booms occupy nearly the whole river, except the channel, sometimes infringing on that, and, so far as this interest is concerned, no further improvement would be necessary.

There is now sufficient depth of water for the tugs, but at many places there are troublesome bars and shoals, and a minimum depth of 12 feet is needed for vessels from the junction of the Tittabawassee and Shiawassee rivers to Bay City.

Any method of improvement which will close up the store-booms or render them difficult of access will injure the commerce of the place to that extent, and the gentlemen begged that the Board would take this fact into consideration in any scheme benefiting the channel.

In addition to bars and shoals, there are a number of sunken water-soaked logs in the river, which impair navigation. As these logs are all owned by some mill or other, it is a misdemeanor for any person to touch them, and yet they are worth so little that the mill-owners will not take the trouble to remove them; only the General Government has this right. There would probably be little difficulty in having these obstructions removed without expense to the Government, provided that they would become the property of the person removing them.

As the spring freshets are very liable to fill in any cuts made during the previous fall, it is desirable that the dredging should be done immediately after the freshets, as it will then be tolerably permanent during the summer. Temporary relief will be needed every year, and a yearly appropriation should be made for this purpose.

The next day, September 14, the Board examined the river, and the existing improvements above and below East Saginaw, and then proceeded to Bay City, where they met the representative business men of that place. These gentlemen concurred in stating that all the relief they needed was dredging, so as to increase the depth of water over the bar at the mouth of the river to at least 14 feet, 16 feet being preferable, and to remove certain bars in front of the city to a depth of 14 feet, the datum level to be the mean low water of the lake. The Board was informed that the water was subject to sudden fluctuations of level on the bar, and, in consequence, in the river also, occasionally as high as 4 feet, and frequently as much as 2 feet, the water falling during strong southerly and rising during northerly winds, the bay being calm during the former and rough during the latter winds, but as the water always rose during rough weather this compensated in part for the play of the waves.

During the visit of the Board to Bay City the water fell 18 inches in two hours, and several vessels were aground in consequence.

The Board then adjourned, subject to the call of the senior member.

On October 18 the Board reassembled at Detroit, Mich., all members present. Maj. F. U. Farquhar had in the mean-time caused resurveys made of certain portions of the river, and collected other information pertinent to the subject.

The present needs of the commerce of Saginaw are as follows:

First. A channel 14 feet deep across the bar at the mouth of the river.

Second. Removal of the shoal immediately above the draw of the Third Street Bridge at Bay City to a depth of 14 feet, to enable vessels to pass through the draw, and of other shoals in front of the city to the same depth.

Third. Twelve feet of water and a channel at least 200 feet wide from Bay City to the head of navigation, this channel to be so made as not to destroy, interfere with, or render difficult of access the store-booms on each side of the river.

To accomplish this the Board has the honor to make the following recommendations:

First. That all snags and logs be taken up, and all store-booms that

project into the channel be removed, notably the boom opposite Sheboyganning Creek, which occupies the best channel of the river. No estimate is made of the cost of this, as it can probably be done without expense to the Government.

Second. That the obstructions between the junction of the Tittabawassee and Shiawassee rivers and the Portsmouth Bridge at Bay City be removed by dredging a channel 12 feet deep and 200 feet wide, the work to be commenced at the worst bars.

ESTIMATED QUANTITIES TO BE DREDGED.

	Cubic yards.
South Saginaw.....	100,000
Saginaw City.....	85,000
East Saginaw.....	135,000
Carrollton Bar.....	115,000
Zilwaukee.....	50,000
New York Works.....	100,000
Willow Island.....	135,000
Total.....	720,000

Third. That the shoals in front of Bay City and immediately above the draw of the Third Street Bridge be removed by dredging a channel 14 feet deep and 200 feet wide. Quantity to be dredged, 80,000 cubic yards. All the above are scow measurements.

Fourth. That dredging be done annually to afford relief after the spring freshets.

To protect the channel all excavated material should be put on the shore where it cannot return to the river.

Fifth. That two cross-dams be built, one behind the revetments at Carrollton and the other across the Oneida Channel, to cut off the flow outside of the improved channels at these points.

Sixth. That the channel across the bar at mouth of river be dredged to a depth of 14 feet and to a width of 200 feet at the bottom.

Estimated quantity to be dredged, 240,000 cubic yards in place.

The following is the estimated cost of the above work:

DREDGING BETWEEN THE JUNCTION OF THE TITTABAWASSEE AND SHIAWASSEE RIVERS AND THE PORTSMOUTH BRIDGE.

270,000 cubic yards, at 25 cents.....	\$180,000
Dredging in front of Bay City, 80,000 cubic yards, at 25 cents.....	20,000
Dredging across bar at mouth of river, 240,000 cubic yards, at \$1.....	240,000
Cross-dam at Carrollton Bar, 700 linear feet, at \$5.....	3,500
Cross-dam at Oneida Channel, 500 linear feet, at \$5.....	2,500
	446,000

The cost of the revetments in the project referred to the Board would be \$113,000, and it is estimated that the annual sum required to keep them in repair would be 5 per cent. of the first cost, or about \$5,500, a sufficient amount to afford relief by dredging after each spring freshet.

All of which is respectfully submitted.

HENRY M. ROBERT,
Major of Engineers.
F. U. FARQUHAR,
Major of Engineers.
D. P. HEAP,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

Recapitulation of money appropriated and labor performed on the Saginaw River.

Year when appropriated.	Amount appropriated.	When labor was performed.	Names and addresses of contractors.	Kind of labor performed and price paid therefor.	Amount of labor performed and material delivered.
1866.....	\$67,500	1866-'67	John Brown & Co	Mouth of river:	3,426 cubic yards.
1867.....	28,000	1867-'68	do	Dredging, at 79 cents per cubic yard.....	79,804 cubic yards.
1868.....	9,000	1868-'69	do	do	24,699 cubic yards.
1870.....	1,500	1872	George Talbot, Buffalo, N. Y.	Survey made.	
1881.....	10,000	1881		Dredging, at 60 cents per cubic yard.....	11,019 cubic yards.
1874.....	15,000	1874-'75	A. T. Wilcox, Monroe, Mich.	Carrollton Revetment: Timber framed and put in place, \$19.50 per M feet, B. M.	700 linear feet of revetment.
1875.....	30,000	1875-'76	A. T. Wilcox, Monroe, Mich.	Furnishing and driving piles, at 16 cents per linear foot.	
1876.....	11,000	1876-'77	H. S. Dale, Chicago, Ill.	Iron bolts and washers, in place, 44 cents per pound.	
				Slabs, in place, \$1.15 per cord.	
				Stone, in place, \$8 per cord.	
				Dredging, 37 cents per cubic yard.	
				Timber framed and put in place, \$19.50 per M feet, B. M.	2,255 linear feet of revetment.
				Dredging, 37 cents per cubic yard.....	23,643 cubic yards.
				Pine timber, framed and put in place, \$18 per M feet, B. M.	825 linear feet of revetment, 350 linear feet bulkhead.
				Furnishing and driving piles, 14 cents.	
				Bolts and washers, per pound, 44 cents.	
				Slabs, in place, per cord, \$1.10.	
				Stone, in place, per cord, \$7.	
				Dredging, per cubic yard, 35 cents.	
				Oak piles driven, per linear foot, 9 cents.	
1878.....	25,000	1877-'79	Carlin, Stickney & Cram, East Saginaw ..	Pine timber, in place, per M feet, B. M., \$14.50.	
1879.....	8,000	1877-'79		Pine timber, in place, per M feet, B. M., \$12.50.	
				Oak timber, in place, per M feet, B. M., \$20.	
				Bolts and straps, in place, per pound, 34 cents.	
				Drift bolts, in place, per pound, 24 cents.	
				Spikes, in place, per pound, 34 cents.	
				Edgings and slabs, in place, per cord, \$1.25.	
				Stone, in place, per cord, \$6.50.	
				Carrollton Training-wall:	
				Piles driven, per linear foot, 19 cents.	
				Pine timber, in place, per M feet, B. M., \$13.	
				Pine timber, in place, per M feet, B. M., \$11.	
				All lumber, in place, per M feet, B. M., \$10.	
				Bolts, chains, and straps, per pound, 44 cents.	
				Cut nails, in place, per pound, 8 cents.	
1878.....	25,000	1877-'79	Castle Sutherland, South Saginaw		
1879.....	8,000				

1880.....	15,000	1879-'80	E. H. French, Fulton, N. Y.....	<p>Zilwaukee Wingdam: Oak piles, driven, per linear foot, 12 cents. Pine timber, in place, per M feet, R. M., \$18. Pine timber, in place, per M feet, R. M., \$16. Oak timber, in place, per M feet, R. M., \$20. Bole, chains, and straps, in place, per pound, 3½ cents. Drift bolts, in place, per pound, 2½ cents. Spikes, in place, per pound, 3½ cents. Edgings and slabs, in place, per cord, \$1.25. Stone, in place, per cord, \$3.50. East Saginaw: Dredging, per cubic yard, 11 cents..... Carrollton Channel (renewed 100 feet wide): Dredging, per cubic yard, 11 cents..... Zilwaukee Bar: Dredging, per cubic yard, 11 cents..... New York Works Bar: Dredging, per cubic yard, 11 cents..... Carrollton Bar: Dredging, per hour, \$16.</p>	<p>4,128 cubic yards. 11,113 cubic yards. 16,388 cubic yards. 15,000 cubic yards.</p>
1881.....	10,000	1880-'81	T. M. Hubbell, Saginaw City.....		

CONSTRUCTION OF HARBOR OF REFUGE AT SAND BEACH, LAKE HURON,
MICHIGAN.

At the beginning of the fiscal year but one contract was in force, namely, with Thomas M. Hubbell for the use of the tug *George Hand*. This contract was closed September 15, 1882. The work of construction was carried on by hired labor, the requisite materials being purchased in open market, and by contract.

For the details of the year's work and the progress made, attention is invited to the report of Assistant Engineer C. F. Gilbert, hereto appended.

It will be seen that the work proposed in the last Annual Report for the remainder of the season of 1882 was completed, and, in addition, three cribs 65 by 26 feet each were placed at the north end of the line extending from the main entrance towards the shore.

The last of these cribs was put in position on the 15th August, 1882, temporary beacons established, and the work properly prepared for the winter. Operations were finally closed for the season on the 30th of October.

Work was resumed on the 17th April, 1883, at which time dredging was begun. Crib construction was resumed on the 1st of May, and up to the 30th of June eight cribs, each 65 by 22 by 15 feet, have been built, sunk, and secured, all in extension shoreward of the south arm of the breakwater.

The project for the season's operations of 1883 contemplated the building and placing of sixteen cribs, each 65 by 22 by 15 feet, and eleven others, each 65 by 18 feet, and from twelve to fourteen courses in height. This, if accomplished (and there now appears to be a fair prospect of it), together with the repairs and dredging, will exhaust the appropriation now available, except a small balance for maintenance and control during the remainder of the fiscal year.

Unless a new appropriation is made by Congress, *available early in the season of 1884*, that season will be lost to the work of construction, causing a year's delay in the completion of harbor, and much extra expense in protecting the incomplete work now in place.

The very best results have attended the appointment of a custodian authorized by Congress. Under the operation of rules and regulations approved by the Secretary of War, he has been enabled to diminish the danger of collision due to crowding and careless handling of the shipping seeking protection in the harbor, and by systematically arranging the positions to be occupied, has practically doubled the amount of accommodation.

The appended table shows that 984 vessels, aggregating 262,213 tons, sought protection here during the fiscal year.

The first appropriation for this harbor was for the fiscal year 1871-'72.

Appropriations, of varying amount (see last Annual Report), were made from year to year, the last being for \$75,000 by act of August 2, 1882.

The aggregate amount thus far appropriated is \$900,000, while the original estimate for the work was \$1,442,500.

It was upon this basis that Congress authorized its commencement, and it is especially gratifying, now that its completion is apparent, to find that its actual cost will only amount to about two-thirds of the original estimate.

It is estimated that the sum of \$175,000 will be required to complete the work upon the present plan, divided as follows:

Superstructure, lake arm.....	\$60,000
Superstructure, south arm.....	40,000
Dredging and repairs	75,000
	<hr/> 175 000

The superstructure work can all be done in one season at a much less expense than by dividing it up into several contracts.

The dredging will require two seasons' work; \$125,000 can therefore be expended to advantage in one season, and I most earnestly recommend that this amount be appropriated for use during the fiscal year ending June 30, 1885.

The question of the renewal of the old superstructure as it decays, in more permanent material than timber, should receive early attention, and experiments to this end be made in connection with the repairs now necessary.

The work is located in the collection district of Port Huron, a light-house stands on the angle crib of the breakwater, and another is projected to mark the end of the breakwater on the northern side of the main entrance.

The amount of customs revenue collected in this district during the fiscal year was \$223,892.79.

The improvement has little local importance, but the entire commerce of the northern and northwestern lakes is interested, and it is safe to say that no work of internal improvement on the entire chain of lakes has proven of more signal value to the general commerce.

Money statement.

July 1, 1882, amount available.....	\$48,381 14
Amount received from sale of fuel	174 37
Amount appropriated by act passed August 2, 1882	75,000 00
	<hr/> 123,555 51
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$69,034 76
July 1, 1883, outstanding liabilities.....	7,959 05
	<hr/> 76,993 81
July 1, 1883, amount available	46,561 70
	<hr/>
Amount (estimated) required for completion of existing project	175,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885 ..	125,000 00

Abstract of bids for furnishing timber for crib-work at the harbor of refuge at Sand Beach, Mich., received and opened by Maj. F. U. Farquhar, Corps of Engineers, on October 21, 1882, in accordance with advertisement dated September 21, 1882.

No.	Names and addresses of bidders.	Lot 1. Hewn or white pine or sawed hemlock, 300,300 feet, B. M.	Lot 2. Hemlock and white pine, 584,160 feet, B. M.	Lot 3. Hemlock and white pine, 371,380 feet, B. M.	Remarks.
		Per M. \$12 00	Per M. \$13 00	Per M. \$13 00	
1	Joseph Van Buskirk, Harrisville, Mich.				Recommended for acceptance.
2	John Hoffman, Port Huron, Mich	14 00	14 00	13 75	
3	John W. McGinn, Cheboygan, Mich	23 00	23 53	23 42	
4	John Hopson, Sand Beach, Mich	{		13 50	For hemlock.
5	F. Crawford, Caseville, Mich		14 00	15 00	For pine.
				13 00	For best hemlock. Informal.

Bid of Joseph Van Buskirk accepted and contract awarded.

1872 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of bids for furnishing iron bolts and spikes for crib-work at the harbor of refuge at Sand Beach, Mich., received and opened by Maj. F. U. Farquhar, Corps of Engineers, on October 21, 1882, in accordance with advertisement dated September 21, 1882.

No.	Names and addresses of bidders.	Aggregate weight 75,320 pounds.	Remarks.
		<i>Per lb.</i>	
1	James Stover, Cleveland, Ohio.....	\$0.03	Recommended for acceptance.
2	Frank Wilson, Cleveland, Ohio.....	.03 ⁷⁵ / ₁₀₀	
3	Black and Owen, Detroit, Mich.....	.03 ¹ / ₂	Iron bolts at 4 ¹ / ₂ c. per lb. Boat spikes ¹ / ₂ by 7 at 4 ¹ / ₂ c. per lb. Informal. Iron bolts, ¹ / ₂ by 12, at 3 ¹ / ₂ c. per lb. Informal. Boat-spikes, ¹ / ₂ by 6, at 6 ¹ / ₂ c. per lb.
4	Paul J. Field, Philadelphia, Pennsylvania....	.04 ⁷⁵ / ₁₀₀	

Bid of James Stover accepted and contract awarded.

Abstract of bids for furnishing dredge, tug, and two dump-scoops for use upon the work of construction at the harbor of refuge at Sand Beach, Mich., received and opened by Maj. F. U. Farquhar, Corps of Engineers, on October 21, 1882, in accordance with advertisement dated September 21, 1882.

No.	Name and address of bidder.	Per hour.
1	John Hickler, Buffalo, N. Y.....	\$7 15

Contract awarded to John Hickler.

Abstract of bids for furnishing a tug for use upon the work of construction at the harbor of refuge, Sand Beach, Mich., received and opened by Maj. F. U. Farquhar, Corps of Engineers, on March 15, 1883, in accordance with advertisement dated March 1, 1883.

No.	Names and addresses of bidders.	Name of tug.	Per month.
1	Blanchard & McAlpine, Detroit, Mich.....	William Park...	\$425
2	Thomas M. Hubbell, Saginaw, Mich.....	George Hand.....	550
3	Louis Dubois, Detroit, Mich.....	C. D. McKinnon.....	745
4	Carkin, Stickney & Cram, East Saginaw, Mich.....	Roy J. Cram.....	800
5	Frank Sayen, Toledo, Ohio.....	A. Andrews, Jr.....	1,140

Bid of Blanchard & McAlpine accepted and contract awarded.

REPORT OF MR. C. P. GILBERT, ASSISTANT ENGINEER.

SAND BEACH, MICH., June 30, 1883.

MAJOR: I have the honor to make the following report of operations at the harbor of refuge, Sand Beach, Mich., for the year ending June 30, 1883.

The work of construction has been prosecuted by hired labor, and by the purchase of material in open market, and by contract.

But one contract was in force at the beginning of the fiscal year, that with Thomas M. Hubbell, for furnishing the tug George Hand, for use upon the work.

This contract was closed September 15, 1882. The work during the season of 1882, was all expended upon material purchased in open market.

Two additional 65 by 38 feet cribs were added to the lake arm of the main pier, completing the substructure of that portion of the breakwater. Three 65 by 26 feet cribs were put in place at the north end of the south line commencing at the south side of the main entrance. The last crib of the season was sunk August 15, after which the filling was completed and the cribs all decked over with a temporary covering of hemlock plank.

A temporary white beacon carrying a red light was placed on the north side of the main entrance, and the south side marked by a post and red lantern.

The face wall on the main pier was extended 375 feet, bringing that work nearly to the east end of the completed superstructure.

The diving crew worked upon the foundations for the next season's cribs, and upon repairs on the old work until October 30, when the construction work at Sand Beach was closed for the season, and the harbor and property placed in charge of a custodian appointed under the act of Congress, approved June 19, 1882.

A steam launch was purchased and sent to Sand Beach for his use during the remainder of the season. The control of boats and vessels taking refuge in the harbor by a custodian acting under the rules and regulations approved by the Secretary of War, has proved of great benefit, practically doubling the capacity of the harbor and greatly diminishing the danger of collision due to crowding, reckless and incompetent handling of the lake craft that seek a refuge during storms.

During the winter contracts were signed with Joseph Van Buskirk for furnishing timber and plank, with James Stover for furnishing bolts and spike, with John Hickler for furnishing dredge, tug, and dump scows, and with Blanchard & McAlpine, for furnishing a tug. All for use during the season of 1883.

Authority was obtained for the purchase in open market of 4,000 cords of boulder stone, and for the prosecution of the work during the season of 1883 by hired labor. Dredging was commenced at Sand Beach, April 17, 1883, and operations upon the work of crib construction were resumed May 1, the plant repaired and crib building commenced soon after. This has been prosecuted to date as fast as weather would warrant.

Eight 65 by 22 by 15 feet cribs have been built, sunk in place, and secured with boulder stone in extension of the south arm of the breakwater.

The delivery of timber under contract with Joseph Van Buskirk has been fully up to the requirements of the work. The iron contract was satisfactorily filled and closed.

The dredging outfit, furnished by John Hickler, has thus far proved efficient and satisfactory.

The tug Wm. Park, furnished by Blanchard & McAlpine, was placed upon the work May 1, 1883, and has been in used to date.

The steam launch has proved a useful addition to the plant upon the work of construction.

In accordance with your instructions the custodian has been used upon the work of construction to the full extent of his surplus time and abilities.

The method of sinking cribs upon foundations built with boulder stone, compactly laid by divers, has been continued with success. Riprap placed the same way has stood the test of very severe storms.

The project for the season's work of 1883, of sixteen 65 by 22 by 15 feet cribs and eleven 65 by 18 feet cribs from twelve to fourteen courses in height, will, with the repairs and dredging, exhaust the appropriation now available for construction work, leaving but a small balance for maintenance and control during the remainder of the year.

The dimensions of the work now in place are as follows:

	Linear feet.
Between north and main entrance	4,680
Completed east of north entrance	3,705
Completed west of north entrance	1,500
Cribs without superstructure, lake arm	975
Cribs without superstructure, south arm	715

Total length in place

6,895

Total material in place in the work, 15,612,515 feet, B. M., timber and plank, 1,228,339 pounds iron, and 49,676 cords of stone.

The project for the present season completes the substructure of the south arm, forming a line of pier 1,950 feet in length; experience may show that a knuckle, or angle will be needed at the south end to completely break off the southeast seas. The necessity for this is not yet apparent.

The appropriation asked for, for the year ending June 30, 1885, should be expended in completing the superstructure over the cribs in place, and in dredging inside the harbor. I would recommend the consideration of the plan of building this superstructure at once of permanent material, and the renewal of the fast decaying old timber work in the same way, rather than the plan of building it at first with timber which will soon decay and require renewal.

A few preliminary experiments in this direction would be valuable.

The work of examining the bottom, inside and around the harbor, through holes cut in the ice should be continued when ice and weather permit of economical and satisfactory work.

1874 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

A new general survey of the harbor and surroundings should be made and a new chart prepared—the chart published by the lake survey in 1876, being now much in error. The necessity for a fog signal and better lighting of the harbor becomes more apparent each year.

Very respectfully, your obedient servant,

C. P. GILBERT.

Maj. F. U. FARQUHAR,
Corps of Engineers.

Tabulated record of vessels taking refuge in the harbor from June 30, 1882, to June 30, 1883, showing kind of vessel, direction of wind at time of entry, &c.

Date.	North.			Northwest.			West.			Southwest.			South.		
	Steam.	Sail.	Tow.	Steam.	Sail.	Tow.	Steam.	Sail.	Tow.	Steam.	Sail.	Tow.	Steam.	Sail.	Tow.
1882.															
July.....	6	1	2	8	5	13	4	2	3	2	4	5	4	1	1
August.....	8	1	9	13	11	16				1	2	2			
September.....	20	11	14	7	6	6	2	1		8	1	3	1	2	
October.....	6	3	1	6	4	8	16	5	30	8	2	23	12	5	3
November.....	16	4	23	10	1	13	6	1	5	26	3	13	5	2	2
December.....		1					10		2	1					
1883.															
April.....	2														
May.....	7	4	2	5	2	5	10	5		1			6	2	3
June.....	3			11	6	12	4	1	2	5	4	6	1	2	
Totals.....	68	25	51	60	35	73	52	15	42	52	16	52	29	14	9
Grand totals.....	144			168			100			130			52		

Date.	Southeast.			East.			Northeast.			Monthly total.			Totals.
	Steam.	Sail.	Tow.	Steam.	Sail.	Tow.	Steam.	Sail.	Tow.	Steam.	Sail.	Tow.	
1882.													
July.....	8	2	8							32	15	32	79
August.....	15	6	11				19	7	17	56	27	55	132
September.....	8		11	1	1		15	7	12	32	29	46	137
October.....	17	11	5				9	4	7	74	34	77	185
November.....	20	2	18				8	2	10	91	15	84	199
December.....										11	1	2	14
1883.													
April.....				3	1	1	12	2	4	17	3	5	25
May.....	16	3	5	5	4	1	12	7	5	32	27	21	110
June.....	2	7		2	5		13	7	13	41	32	33	106
Totals.....	86	31	58	11	11	2	88	38	68	446	183	355	994
Grand totals.....	175			24			193			984			.....

In Gap, total 94. Out Gap, 216.

Tonnages: Steam, 135,478.58; sail, 25,968.69; tow, 100,748.17; total, 262,215.44.

Tonnage of vessels entering harbor of refuge, Lake Huron, Michigan.

Calendar year.	Steam.	Sail.	Unrigged.	Total.	No. of vessels.	Average tonnage.
1877.....	63,966	27,099	50,954	142,019	493	289
1878.....	104,025	39,099	39,232	242,096	781	312
1879.....	123,060	45,750	100,096	278,906	921	303
1880.....	158,702	55,630	147,260	361,592	1,317	275
1881.....	144,645	55,580	127,655	328,480	1,176	280
1882.....	146,132	26,504	114,067	286,703	1,022	280
Totals.....	750,550	251,242	639,514	1,641,306	5,710	289

J J 9.

IMPROVEMENT OF ICE HARBOR OF REFUGE AT BELLE RIVER,
MICHIGAN.

The project for this improvement was adopted in 1880, the object being to make a channel 50 feet wide, 13 feet deep to the first bridge, and 12 feet deep from there to the second bridge.

Under the appropriation of \$5,000 made by the act of August 2, 1882, a contract dated September 12, 1882, was entered into with Thomas M. Hubbell, of Saginaw, Mich., for dredging to the extent admissible by the amount of the appropriation, at 16 cents per cubic yard, scow measurement.

Operations were begun on the 1st October and continued until November 25, when they were stopped for the season by cold weather and the formation of ice.

During this time 11,235 cubic yards of material were removed. Work was resumed on the 28th April, 1883, and continued until June 6, by which time 17,000 cubic yards had been removed and the available funds exhausted.

The total amount of material removed under this appropriation was 28,235 cubic yards.

The material dredged consisted of hard and stiff clay, and the result of the year's work is one cut 12 feet deep between the first and second bridges, and a second cut for about half that distance.

To complete the improvement under the present project will require a further appropriation of \$2,000.

The original estimate for the work, exclusive of revetment, was.....	\$14,465
The appropriations have been :	
Act of March 3, 1881.....	\$7,000
Act of August 2, 1882	5,000
	<hr/> 12,000
Difference	2,465
Amount of estimate to complete.....	2,000
	<hr/>
Probable cost less than original estimate.....	465

Belle River is in the collection district of Huron, Mich., the nearest port of entry being Port Huron, and the nearest light-house at Fort Gratiot, Mich.

Money statement.

July 1, 1882, amount available.....	\$180 67
Amount received from sale of fuel.....	25 13
Amount appropriated by act passed August 2, 1882.....	5,000 00
	<hr/> 5,205 80
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	5,085 04
	<hr/>
July 1, 1883, amount available.....	120 76
	<hr/>
Amount (estimated) required for completion of existing project.....	2,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	2,000 00

1876 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of bids for dredging, improving ice harbor of refuge at Belle River, Michigan, received and opened by Maj. F. Harwood, Corps of Engineers, on September 12, 1882, in accordance with advertisement dated August 21, 1882.

No.	Names and addresses of bidders.	Dredging, scoiw meas- urement.
		<i>Per cub. yd.</i>
1	Thomas M. Hubbell, Saginaw, Mich	\$0 16
2	Carkin, Stickney & Cram, East Saginaw, Mich	24
3	James Rooney, Jr., Toledo, Ohio	25
4	Louis P. Smith and James A. Smith, Cleveland, Ohio	26

Contract awarded to Thomas M. Hubbell.

J J 10.

OPERATING AND CARE OF SAINT CLAIR FLATS SHIP-CANAL, MICHIGAN.

At the beginning of the fiscal year cavities in the canal banks resulting from the swells of passing steamers were being filled with cedar bark.

During the months of July and August, 1882, 258 cords were so placed, and in October, 1882, 115 cords more were purchased and disposed of in like manner.

An ice-breaker, designed under the direction of Maj. F. Harwood, was built in November and December, 1882, at the upper or northerly end of the east bank of the canal.

It is composed of three rows of piles securely bound and bolted together with waling timbers and binder pieces, the apex or up-stream point being provided with iron facing bolted to the timbers.

It was constructed by A. J. Dupuis, under the personal supervision of the custodian of the canal, Mr. William H. Mott, and cost \$2,014.64.

On January 9, 1883, a plan for the restoration of the canal banks, the timber-work of which above water had fallen into decay, was submitted by Maj. F. U. Farquhar, Corps of Engineers, United States Army, with an estimated cost of \$132,908.

A survey on the ice was made during the last two weeks of January, 1883, 7,875 soundings taken, and the result platted and forwarded to the Chief of Engineers, March 5, 1883.

During the month of April, 1883, the willows were trimmed, as is usual in the spring of every year, the clippings tied into bundles or fascines, and deposited within the ice-breaker at the upper end of the east pier; and in June 42 cords of stone, taken from the Lime Kiln Crossing, Detroit River, were placed on top of the brush, sinking it to the bottom.

During May, 1883, some minor repairs were found necessary to the sheet-piling, and they were done by day labor.

In June, 1883, finally, 92 cords of cedar bark were used in filling cavities in the canal banks.

The amount expended during the fiscal year ending June 30, 1883, is \$5,668.87, which was applied to the construction of the ice-breakers at the head of the east bank, some minor repairs, and the care and custody of the canal and the Government property.

The estimated cost of operating and care of the canal for the fiscal year beginning July 1, 1883, is as follows:

Salary of custodian.....	\$1,500
Current repairs which cannot be foreseen nor estimated in detail.....	10,000
Total.....	11,500

This work is in the collection district of Detroit, Mich. Two light-houses are located on the canal banks.

Money statement.

July 1, 1882, amount available.....	\$1,173 38
Amount allotted for operating and care.....	5,000 00
	6,173 38
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$5,110 37
July 1, 1883, outstanding liabilities	558 50
	5,668 87
July 1, 1883, amount available.....	504 51
Amount (estimated) required for fiscal year 1883-'84.....	11,500 00

GENERAL REPAIRS AND RENEWALS.

The necessity for repairs to this work is constantly recurring, arising from the manner of its construction and the materials used. The original plans were made for a channel depth of 13 feet, and width of 300 feet, which was considered ample at that time. Subsequently (in 1873) it was found necessary to increase the available depth in the channel, which was done by excavating for 100 feet on each side of the axis of the canal to a depth of 16 feet, leaving the bottom on either side of this deepened channel to take such slope as it would assume. It was thought that this berme on each side, of nearly 50 feet in width, with a height of 3 feet (slope about 1 to 16), would be ample to support the lower ends of the sheet-piling, and, but for the occasional action of propeller wheels when violently turned near to or in contact with the sides of the canal, it would do so. Some of the caving of the sides referred to in former reports has undoubtedly arisen from the undermining of the sheet-piling from this cause. But I am of opinion that much the greater portion of the difficulty has been due to the fact that the sheet-piling is a single course, and, not joining closely, the fine sand of the bank finds its way through the interstices.

Two projects have been submitted for the radical cure of this defect—the first by Major Harwood, United States Engineers, under date of February 24, 1882; the second, by Major Farquhar, on the 9th January, 1883. Each of these officers also included projects for the repair of the superstructure, and the latter one for replacing the superstructure of the revetment on the lake side of the piers.

Of these two plans, I prefer the one submitted by Major Farquhar, and append a copy of his report, which I recommend for adoption. He gives an estimate in detail, which, in the aggregate, amounts to \$132,908.

If this plan be adopted, it would be well to appropriate the whole amount at once, in order that the entire work could be included in one

contract and pushed to early completion. If this is not deemed advisable, then the sum of \$75,000 should be appropriated with which to begin the work, which in that event should be *completed* as far as the appropriation would suffice to carry it.

Original estimated cost of the work, 1866	\$428, 754 00
It was entirely completed, according to the original plan, for about	472, 400 00
Since completion as above, the expenditure on account of custody, repairs, and deepening the channel an additional 3 feet has been about	134, 485 09
Whole amount expended to June 30, 1883	606, 885 09
The entire amount appropriated and allotted for the work, to 30th June, 1883, has been	607, 389 60

Abstract of bids for furnishing, driving, and securing piles for improvement of Saint Clair Flats ship-canal, opened September 2, 1882, by Maj. Franklin Harwood, Corps of Engineers.

No.	Names and addresses of bidders.	White-oak piles, 5,700 linear feet.	White-oak timber, 3,540 feet, B. M.	White-pine timber, 2,060 feet, B. M.	Date of beginning work.	Amount.
		<i>Per lin. ft.</i>	<i>Per foot.</i>	<i>Per foot.</i>		
1	A. J. Dupuis, Detroit, Mich.	\$0 29	\$50	\$40	September 20, or sooner	\$1, 913 28
2	Fleming & Candler, Detroit, Mich.	30	60	40	Two weeks after notice	2, 085 00
3	John A. Smith, Algonac, Mich.	36	75	75	Work to be done with dispatch, and completed the fall of 1882	2, 473 50
4	Carkin, Stickney & Cram, Detroit, Mich.	38	70	60	Thirty days from date	.....

Contract awarded to A. J. Dupuis.

REPORT OF MAJOR F. U. FARQUHAR, CORPS OF ENGINEERS.

DETROIT, January 9, 1883.

GENERAL: Referring to a letter to you written by Maj. F. Harwood, Corps of Engineers, dated February 24, 1882, on the subject of the repairs necessary at the Saint Clair Flats Canal, and to his annual report for the year ending June 30, 1882, I have the honor to call your attention to the same subject and to submit the following report:

The original cross-section of the canal as finished in 1871 was 300 feet wide and 13 feet deep, with banks 5 feet high above water, revetted below water, on the channel faces, with a single row of sheet-piles 16 feet long supported between the walings and binders of a row of piles about 6 feet apart, and revetted above water level by a timber revetment; the whole revetment tied back into the bank by proper ties fastened to a cross-wall in the middle of bank.

As at first planned no revetment was designed for the lake faces of the banks, but it was soon found that one was necessary, and a very frail one of a single row of sheet-piles extending to the top of the bank, supported by a row of piles, was constructed.

In 1873-'74 the channel for a width of 200 feet was deepened, leaving a berme of about 40 feet on each side only 13 feet deep.

In many places this berme has been washed away by the current or by the action of the wheels of steamers, and the ends of the sheet-piles

was originally creosoted, but the process was very imperfect, and the three upper courses of timber are very rotten, and almost useless as a protection to the banks.

The two lower courses are generally in good condition, as well as the lower course of ties. On the lake faces of the bank the sheet-piling above water level is rotten, and the banks are much deteriorated.

The willow trees planted in 1874-'75 are in flourishing condition, except where destroyed by the lines of vessels, and their roots have done much to consolidate the banks.

The first work that should be done is to drive a double row of sheet-piling along the channel faces of both banks of the canal, as shown on the accompanying tracing, and tie it to the present work by screw-bolts. The top of the new work should be at the surface of lowest water. This will serve three purposes: First, to close all leaks through the present single row of sheet-piling; second, as a support for any revetment above water (stone or otherwise) that may in the future be built; and third, will serve as a fender to keep vessels off from the above-water revetment.

In renewing the superstructure I would recommend creosoted boards, 12 by 3 inches, spiked one on top of the other, and braced by an outside brace of timber 6 by 12 inches from the top of each supporting pile of the proposed new under-water revetment. Lumber 12 by 3 inches and 6 by 12 inches can be thoroughly creosoted, and at no great cost for handling.

On the lake faces of the bank I would recommend the cutting down of the present pile revetment to lowest water surface, and constructing a plank beam revetment of creosoted boards, as shown on accompanying tracing.

By these plans of plank beam revetments, supported by an outside brace, the risk and cost of damage to the willows from digging up trenches to put other ties in will be avoided.

The cost of the proposed work is estimated as follows:

UNDER-WATER REVETMENT.

2,345,200 feet, B. M., pine timber, at \$16 per M	\$37, 523 00
67,500 linear feet oak piles, at 30 cents per foot.....	20, 250 00
23,000 pounds screw bolts, at 5 cents per pound	1, 150 00
22,500 pounds spikes, at 3½ cents per pound.....	787 50
Driving 14,400 running feet sheet-piles, at \$1 per foot	14, 400 00
	<hr/>
	74, 110 50
Contingencies.....	7, 411 50
	<hr/>
Total	81, 522 00

ABOVE-WATER REVETMENT, CHANNEL FACES.

592,800 feet, B. M., pine lumber, creosoted and put in place, at \$32.50 per M.	\$19, 265 00
37,500 pounds spikes, at 3¼ cents per pound	1, 312 50
	<hr/>
	20, 577 50
Contingencies.....	2, 057 50
	<hr/>
Total	22, 635 00

1880 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

ABOVE-WATER REVETMENT, LAKE FACES.

6,331,000 feet, B. M., creosoted pine lumber, at \$35.50 per M.....	\$20,615 02
153,000 feet, B. M., pine timber, at \$20 per M.....	3,060 00
55,000 pounds spikes, at 3½ cents per pound.....	1,925 00
5,175 pounds screw bolts, &c., at 5 cents per pound.....	258 75
Cutting of 14,400 running feet sheet piles, at 2 cents.....	288 00
Contingencies, 10 per cent.....	2,613 43
Total.....	28,751 00
For channel faces below water.....	81,522 00
For channel faces above water.....	22,631 00
For lake faces above water.....	28,751 00
Total.....	132,904 00

The above seems a large sum to be expended in repairs of a single work, but there is no single work for the improvement of navigation of any of the inland waters of the United States that exercises such an influence on commerce, or the destruction or deterioration of which would cause such damage to the inland commerce of the United States as the Saint Clair Flats Canal.

The first work should be the under-water revetment of the channel faces. This should be done by contract, after due advertising, and when done would keep vessels away from the above-water work.

Should these recommendations, or any part of them, meet with your approval, I would request early notification of the fact, as the piles should be gotten out before the end of the winter.

Very respectfully, your obedient servant,

F. U. FARQUHAR,
Major of Engineers.

The CHIEF OF ENGINEERS.

JJ II.

IMPROVEMENT OF CLINTON RIVER, MICHIGAN.

Operations in continuation of the project of the Board of Engineers constituted by Special Orders No. 92, dated Headquarters Corps of Engineers, United States Army, Washington, D. C., July 27, 1880, were resumed as soon as the appropriation of \$6,000 made by act of August 2, 1882, became available. During the months of August, September, and October, 1882, eight brush mattresses were constructed 100 by 30 feet by 1 foot, and sunk in extension outward of the mattress-work on the north side of the channel, also three smaller mattresses to fill gaps. The row of clusters of piles, seven in each, intended as ice-breakers for protection of the mattress-work, which was begun in the spring of 1882, was completed throughout the entire length of the channel, there being twenty-three clusters, about 100 feet apart, each well bound with chain.

A pile-crib 40 feet square was constructed at the terminus of the line of piles in 10 feet of water, marking the outer channel entrance from Lake Saint Clair. There were sixty-eight piles, 6,560 feet, B. M., pine timber; 1,680 feet, B. M., oak timber; 1,600 feet, B. M., pine plank; 630 pounds screw-bolts, 437 pounds drift-bolts, and 150 pounds of spikes, used in the construction of this crib, at a cost of \$1,109.75.

Sixteen hundred bundles of brush were placed in the crib in November, 1882, and sixteen hundred and seventy-five bundles of brush and

about 22 cords of stone in May, 1883, which filling projects, however, but a trifle above the surface of the water.

The channel was redredged during the months of September and October, 1882, to a depth of 9 feet and width of 60 feet, 6,123 cubic yards of sand being removed and deposited in Lake Saint Clair.

No examination has since been made; hence the condition of the work at the close of the fiscal year cannot be accurately stated. The high water which has prevailed thus far during the season of 1883 has prevented any complaints from navigators, if any cause therefor has existed.

An examination of the mattress and pile work was made on April 26, 1883, which elicited the fact that but 10 clusters of piles were left intact by the ice, and the southeast corner of the crib was considerably damaged by vessels which had run into it. The mattress appeared to be in fair condition, though sunk below water surface.

A considerable sum of money has already been expended upon attempts to improve the entrance into Clinton River, and thus far without adequate benefit.

It is my firm belief that only radical measures will accomplish the object, and these will necessarily be costly. Whether the object to be attained is sufficiently great to warrant such an expenditure is a question. It is useless to make further effort in this direction with such small appropriations as have been heretofore made. Whatever is undertaken must be carried to completion in one season, in order that it may not be in great measure undone during the following winter.

Major Harwood's estimate of 1882 was for \$20,000, of which \$10,000 should be available to begin one season's operations with. It is my opinion that Major Harwood's estimate of the ultimate cost of the work is entirely too low.

It must not be forgotten that the navigable depth of this portion of Lake Saint Clair is only 10 feet. Consequently the formation of a bar of only 5 feet in height is all that is required to render useless any improvement that may be made. However far (within a distance of 4 miles) protection to the channel is extended, this bar is almost sure to form in a comparatively short time.

If it be desired to continue operations, a sum of not less than \$10,000 should be appropriated at one time, and if made at the usual time at the next session of Congress, work should not actually be resumed before the opening of the season of 1885.

This work is situated in the collection district of Detroit, Mich., which is the nearest port of entry. The nearest light-house is Saint Clair Flats beacon.

Estimated cost of existing project	\$25,000
Amount appropriated to date	8,000

Money statement.

July 1, 1882, amount available	\$502 84
Amount received from sale of fuel	39 38
Amount appropriated by act passed August 2, 1882	6,000 00
	<hr/>
	6,542 22
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$5,969 93
July 1, 1883, outstanding liabilities	150 00
	<hr/>
	6,119 93
July 1, 1883, amount available	422 29
	<hr/>
Amount (estimated) required for completion of existing project	20,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	10,000 00

No.	Names and addresses of bidders.	White-oak piles, 3,828 linear feet.	Norway-pine piles, 3,828 linear feet.	White-oak timber, 8,240 feet, B. M.	White-pine timber, 8,240 feet, B. M.	Norway-pine plank, 1,600 feet, E. M.	Dredging 5,000 cubic yards.	Date of beginning work.	Amount.
		<i>Per ft.</i>	<i>Per ft.</i>	<i>Pr. M/ft.</i>	<i>Pr. M/ft.</i>	<i>Pr. M/ft.</i>	<i>Pr. cu. yd.</i>		
1	Thomas M. Hubbell, Saginaw, Mich.	-----	-----	-----	-----	-----	\$0 20	Upon notification of award.	\$1,200 00
2	Carkin, Stickney & Cram, Detroit, Mich.	\$0 30	-----	\$05	\$45	\$45	30	Sept. 15, 1882	1,800 00
3	Fleming & Candler, Detroit, Mich.	40	\$0 40	55	50	30	-----	Ten days or two weeks.	1,753 00
4	Augustus J. Dupula, Detroit, Mich.	32	30	70	50	50	-----	Sept. 15, 1882	1,588 00
									2,029 20
									1,879 20
									1,638 00

Contract for dredging awarded to Thomas M. Hubbell.

Contract for material and labor awarded to Carkin, Stickney & Cram.

J J 12.

IMPROVEMENT OF DETROIT RIVER.

LIME KILN CROSSING.

The appended report of H. Kallman, assistant engineer in charge of this improvement, shows clearly and concisely the operations during the fiscal year ending June 30, 1883.

As originally projected the improved channel was to be curved, 300 feet wide, with a uniform depth of 20 feet.

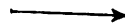
On the 2d February, 1883, Colonel Farquhar recommended to the Chief of Engineers a modification of the project, which would result in a straight channel of the same width and depth, and submitted an estimate of the increased cost arising from such a modification, at the same time presenting the arguments in favor of it.

I heartily concur in this recommendation, and repeat his estimate.

At the close of the fiscal year 1882-'83 but a comparatively small balance remained of former appropriations, and the entire amount will be exhausted early in August and work will stop. It is of great importance that this improvement should be prosecuted to early completion upon the modified plan. If the amount of the estimate (\$227,700) be appropriated in one sum the cost will be materially lessened, and the beneficial results will the sooner be available. As the work now stands it is practically valueless until completed.

Attention is especially invited to the fact that, including the additional cost due to the proposed modification, the actual cost of the improvement will be less than one-half the original estimate, which was before Congress when the first appropriation was made.

The original estimate of the probable cost of the work was.....	\$1,166,500
Amount heretofore appropriated.....	\$335,000
Amount of estimate for completion under proposed modification.....	227,700
	<hr/> 562,700
Actual cost less than estimated	603,800



15

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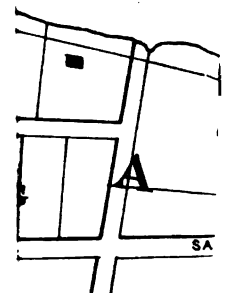
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Line of Ranges

Ranges

25 Ft Curve from

Line of Ranges



the work is located in the collection district of Detroit, Mich. The nearest port of call is Detroit, Mich., and the nearest light-house is Mamajuda, in Detroit River.

A tracing showing the progress of the work during the year is herewith inclosed.

The immense interest concerned in this improvement is apparent from the statistics given in Mr. Kallman's report, and may be summed up in a simple statement that the commerce to be benefited is the largest that passes any point on any inland water channel in the United States. The actual tonnage passing the point during the year 1882 was five times that crossing Detroit River by way of the railroads during the same year; that is to say, as 17,872,182 tons is to 3,327,348 tons.

Money statement.

July 1, 1882, amount available.....	\$1,016 27
Received from sale of fuel.....	13 12
Amount appropriated by act passed August 2, 1882.....	60,000 00
	61,029 39
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$36,991 58
July 1, 1883, outstanding liabilities.....	16,520 25
	53,511 83
July 1, 1883, amount available	7,517 56
Amount (estimated) required for completion of existing project.....	227,700 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	227,700 00

Abstract of bids for improving Detroit River, Michigan, received and opened by Maj. F. U. Farquhar, Corps of Engineers, on September 21, 1882, in accordance with advertisement dated August 31, 1882.

No.	Names and addresses of bidders.	Solid rock.	Loose rock.
		<i>Pr. cu. yd.</i>	<i>Pr. cu. yd.</i>
1	Charles F. Dunbar, Buffalo, N. Y.....	\$7 50	\$1 00
2	David W. McConnell, Buffalo, N. Y.....	8 40	2 00
3	John Hickler, Buffalo, N. Y.....	8 16	1 80

Contract awarded to Charles F. Dunbar.

REPORT OF MR. H. KALLMAN, ASSISTANT ENGINEER.

GROSSE ISLE, MICH., July 2, 1883.

SIR: I have the honor to submit the following report upon the progress of the work of improvement of Detroit River at Lime Kiln Crossing during the fiscal year ending June 30, 1883.

One month previous to the beginning of the year the work was stopped for want of funds.

Under the appropriation of \$60,000 made by an act of Congress passed August 2, 1882, a contract was signed with Mr. Charles F. Dunbar September 21, and by September 25 the drill commenced work and was at work day and night until December 8.

The dredge worked steadily from October 9 to December 8, when the work was suspended for the winter, on account of the heavy running ice in the river.

Work was resumed April 6, and by June 12 the drilling was finished.

Dredge No. 1 finished dredging June 22, and dredge No. 2 is doing the "cleaning

* All of which is under contract and will be expended early in August, 1883.

1884 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

up," which will also be completed about July 20, when the work will again stop until a new appropriation has been made available.

Under the present contract an area of over 40,000 square feet had to be drilled and blasted $1\frac{1}{2}$ to 2 feet below grade, to obtain grade, as a heavy layer of rock $3\frac{1}{2}$ feet thick covered that portion.

The amount excavated is 50 per cent. more than the estimate the contractor receives.

The amount of work done during the year ending June 30 was as follows:

Area drilled, blasted, and dredged (not cleaned).....	square feet..	90, 000
Solid rock removed (pit measurement).....	cubic yards..	6, 534
Amount which will be removed under the present contract	do.....	656

Total amount of work done to date:

Area drilled, blasted, and dredged	square feet..	452, 121
Solid rock removed (pit measurement).....	cubic yards..	38, 602
Solid rock removed (scoow measurement).....	do.....	2, 632
Loose rock removed.....	do.....	849

After the completion of the present contract there remains to be removed a quantity of 27,601 cubic yards of solid rock, which at \$7 per cubic yard amounts to \$193,207.

If Congress appropriated the total amount, 15 per cent. will be saved and the work can be completed in two seasons. To carry on this kind of work under small appropriations is expensive, and commerce will only be benefited by this improvement when it has been completed.

Accompanying tracing marked No. 1 shows the progress of the work and the alteration made by straightening the curved cut. An additional survey and estimate have been made to ascertain the increase of rock excavation for establishing a straight cut. This amounts to 4,872 cubic yards, which at \$7 per cubic yard will cost \$34,104, and is included in the above estimate.

Tracing No. 2 shows the observations on the water-gauges during the time the work has been in progress. During the last year the stage of the water has been unusually high, and therefore less damage has been done to vessels.

The following statistics show the importance of this improvement:

The loss by detention and damage by striking and sinking to boats of only the four following steamboat companies, Union, Anchor, Commercial, and Western Lines, during the seasons of 1880, 1881, and 1882, amounted to \$410,000.

One hundred and fifty-six propellers and steam-barges from 1,000 to 2,600 tons measurement, averaging fifteen round trips during the season, and a large number of sailing vessels, are unsafe when passing the Lime Kiln Crossing.

The official statements of the collectors of United States customs at the lake ports show that the number of American vessels cleared from them which passed through the Detroit River during the seasons of 1880, 1881, and 1882 was as follows:

Season.	No. of vessels.	Tonnage.	Value.
1880	40, 521	20, 235, 249	.....
1881	35, 888	17, 572, 240	.....
1882	35, 199	17, 572, 182	\$281, 994, 619

The following statement shows the number of loaded cars which crossed the Detroit River during the years of 1881 and 1882:

Railroads.	East bound, 1881.	West bound, 1881.	East bound, 1882.	West bound, 1882.
Great Western	76, 065	62, 716	61, 636	61, 397
Canada Southern	92, 939	72, 897	69, 357	84, 869
Total	169, 004	135, 613	130, 993	146, 266

At an average of 12 tons per car: 1881, 3,655,404 tons; 1882, 3,327,348 tons.

Very respectfully, your obedient servant,

H. KALLMAN,
Assistant Engineer

Maj. F. U. FARQUHAR,
Corps of Engineers, U. S. A.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 14, 1883.

SIR: I have the honor to submit the inclosed copy of a report to this office (with accompanying map) from Maj. F. U. Farquhar, Corps of Engineers, dated the 2d instant, in relation to the improvement of the Detroit River at the Lime Kiln Crossing, from which it will appear that the present plan for the work is to excavate a *curved* channel 150 feet wide and 20 feet deep, and that for this he proposes to substitute a *straight* channel of the same dimension, which can be readily lighted, and thus made safer for navigation at all times. The work already accomplished upon the curved channel will be utilized in the proposed straight one; and the additional estimated cost involved in this change of plan will not exceed \$40,000—a small sum in consideration of the great benefit that will inure to navigation and commerce.

In view of the importance of the subject, I beg to suggest that this matter be transmitted to the Speaker of the House of Representatives for the information of the Committee on Commerce.

Very respectfully, your obedient servant,

H. G. WRIGHT,
Chief of Engineers,
Brig. and Bvt. Maj. Gen.

Hon. ROBERT T. LINCOLN,
Secretary of War.

SPECIAL REPORT OF MAJOR F. U. FARQUHAR, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., February 2, 1883.

GENERAL: I have the honor to inclose herewith a tracing* showing the condition of the work of improving the Detroit River at Lime Kiln Crossing.

The parts hachured over have been excavated to the required depth of 20 feet. Under the present contract the remainder of the west half of the proposed cut will be finished, and a channel 150 feet wide will be available for navigation.

There will be a curved channel, and should a vessel strike against its rocky, jagged edges it would most likely go to the bottom. A very serious objection to a curved channel is the impossibility of lighting it for night navigation. An inspection of the tracing will show that by making the straight cut there shown it can be lighted by range lights placed just below on the Canada shore, and that it will conform very nearly to the direction of the current, as shown by the observed direction of the floats before any work was done. This will utilize all the work already done, as it will give each end of the cut a bell mouth.

The increase of excavation over the curved channel is but 4,872 cubic yards, which will cost about \$40,000.

The total amount of rock to be removed after the completion of the present work under contract, and for which an additional appropriation must be made, is 27,601 cubic yards of rock, which will cost, including

* Omitted. Printed in House Ex. Doc. No. 80, Forty-seventh Congress, second session.

the work \$562,700. The original estimate of the cost of the improvement was \$1,166,500; so, even with the above increase, the work will be finished at less than half the sum that was estimated. It will be seen that no current sets across the line of the proposed cut even before it is finished, and the effect of the cut will be to give a direction to the current through it. I have made a careful study of the locality from personal observation, inspection of maps, and conversation with navigators and they all agree in showing the great desirability of having a straight channel that can be so marked as to make its navigation at all time practicable.

The importance of this work to the commerce of the country is second to none in the United States. The commerce to be benefited is the largest in tonnage that passes any point on any inland water channel in the United States, and the vessels navigating the Detroit River are for the greatest part owned by citizens of the United States.

Very respectfully, your obedient servant,

F. U. FARQUHAR,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

J J 13.

REMOVING SUNKEN VESSELS OBSTRUCTING OR ENDANGERING NAVIGATION.

The annual report of Lieutenant-Colonel Weitzel for last year contains all the information relating to the contract for the removal of the wreck of the steamer Nile, lying in Detroit River in front of the city of Detroit. The contract had been awarded to Horatio N. Jex, of Port Huron, Mich., but nothing had been done by the contractor towards the actual prosecution of the work.

On the 10th July, 1882, Mr. Jex began operations, and the work was completed on the 25th of the same month, in accordance with the terms of the contract.

During the remainder of the fiscal year no occasion arose for any similar work, nor is any now known to exist.

Money statement.

July 1, 1882, amount available.....	\$471 06
Amount allotted.....	1, 065 27
	<hr/> 1, 536 32
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	1, 536 32

APPENDIX K K.

IMPROVEMENT OF HARBORS ON LAKE ERIE WEST OF ASHTABULA— IMPROVEMENT OF SANDUSKY RIVER.

*REPORT OF MAJOR L. COOPER OVERMAN, CORPS OF ENGINEERS,
OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883,
WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

- | | |
|--------------------------------|--------------------------------|
| 1. Monroe Harbor, Michigan. | 7. Vermillion Harbor, Ohio. |
| 2. Toledo Harbor, Ohio. | 8. Mouth of Black River, Ohio. |
| 3. Port Clinton Harbor, Ohio. | 9. Rocky River, Ohio. |
| 4. Sandusky City Harbor, Ohio. | 10. Cleveland Harbor, Ohio. |
| 5. Sandusky River, Ohio. | 11. Fairport Harbor, Ohio. |
| 6. Huron Harbor, Ohio. | |

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, July 11, 1883.

GENERAL: I have the honor to submit herewith the annual reports of the works of river and harbor improvement under my charge for the fiscal year ending June 30, 1883.

I am, general, very respectfully, your obedient servant,

L. COOPER OVERMAN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

K K 1.

IMPROVEMENT OF MONROE HARBOR. MICHIGAN.

The harbor of Monroe, Mich., is situated at the extreme westerly bend of Lake Erie, about $1\frac{1}{2}$ miles west of the old mouth of the Raisin River, and about $3\frac{1}{2}$ miles from the town of Monroe.

This improvement was commenced in the year 1835, at which time the Raisin River was considered an important stream, and Monroe was a place of some prominence. The plan of improvement consisted in straightening the river and making direct connection with Lake Erie by a canal 4,000 feet long and 100 feet wide, through a sand peninsula. A description in detail of the operations heretofore carried on for the improvement of this harbor will be found in Annual Reports of 1880 and 1881.

OPERATIONS DURING THE FISCAL YEAR.

By the act passed August 2, 1882, an appropriation of \$1,000 was made for Monroe Harbor.

During the months of August and September materials were purchased in open market, and repairs both to piers and revetment made by hired labor.

One thousand linear feet of the old revetment of the United States canal was renewed or repaired.

Seven hundred and thirty-three linear feet of the old revetment built prior to 1879 was thoroughly repaired and strengthened with additional plank and walling pieces. The repairs on both piers consisted in replacing the old deck plank with new material.

In repairs to piers the following materials were used :

- 672 feet B. M. of oak timber (old material).
- 1,566 feet B. M. of oak plank (new material).
- 540 feet B. M. of pine timber (old material).
- 6,032 feet B. M. of pine plank (new material).
- 362 pounds of iron, 262 pounds of wrought spike (new).
- 308 pounds of wrought spike (old).

In repairs to revetment the following materials were used :

- 4,498 feet B. M. of sawed white-oak plank.
- 942 feet B. M. of oak timber (old).
- 742 pounds of screw and washer bolts (new).
- 525 pounds of screw and washer bolts (old).
- 249 pounds of wrought spike.

Total amount expended in repairs to piers and revetment \$499.66, which put the piers in fair condition. Operations were suspended at the end of September, 1882, there being only a balance of \$516.79 available, which it was deemed best to hold until after the spring freshets of 1883, or for some especial emergency.

The whole amount appropriated for this harbor to date has been \$213,515.27 of which amount \$213,020.88 has been expended.

PRESENT CONDITION OF THE HARBOR AND PROPOSED PROJECT OF IMPROVEMENT.

Through the outer bar and between the piers there is a depth of from 11 to 14 feet. The north pier is 1,350 feet long and the south pier 935 feet long. At their inner end the piers are about 100 feet apart and run parallel to each other until a point is reached about 500 feet from the commencement of the south pier. Here they begin to flare and are 200 feet apart at the outer end of that pier. The depth between the piers decreases as soon as the flaring commences. A bar is forming just beyond the piers.

The United States canal is about 4,000 feet long and 100 feet wide, and has a depth of from 10 to 12 feet. From its upper end to a point just below the docks at Monroe the depth of channel varies from 10 to 18 feet. Near the Monroe docks rock is found upon which there is a depth of only 8½ feet. The piers are in bad condition and some minor repairs are immediately necessary, a few deck plank are needed, some stone for filling required, and a few timbers should be replaced.

The portions of the piers below ordinary low water are very badly rotted down.

The revetment to the United States canal needs to be repaired for about 1,000 feet linear.

While the present commerce of Monroe is not sufficient to justify so large an expenditure at this time, nevertheless, if it is intended to keep up the harbor, the amount estimated is absolutely necessary to prevent the piers from going to pieces. The whole of this sum, \$20,000, can be profitably expended upon the work during the next fiscal year in repairing piers and revetments.

While agreeing fully with him as to the cost, I do not agree as to the necessity, for it would seem as well to abandon the present work to the destructive influences of time and the elements rather than to expend \$20,000 in repairs at a harbor which commerce abandoned years ago.

A slight annual expenditure of, say, \$1,000, will in my opinion keep the piers and revetment standing until it is decided whether any commercial interest hereafter will require these extensive renewals.

The harbor of Monroe is in the collection district of Detroit, Mich. There is a fixed white light of the fourth order on the outer end of the west pier. The nearest work of defense is Fort Wayne, 30 miles distant.

The amount of revenue collected during eleven months ending May 31, 1883, was \$16.85.

There were no imports. The value of the exports was \$5,000.

Twenty-two vessels, with an aggregate tonnage of 960 tons, entered, and eighteen vessels, with an aggregate tonnage of 1,009 tons, cleared during the eleven months ending May 31, 1883.

Money statement.

July 1, 1882, amount available.....	\$16 45
Amount appropriated by act passed August 2, 1882.....	1,000 00
	<hr/>
	1,016 45
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	522 06
	<hr/>
July 1, 1883, amount available.....	494 39
	<hr/>
Amount (estimated) required for completion of existing project.....	20,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	2,000 00

K K 2.

IMPROVEMENT OF TOLEDO HARBOR, OHIO.

The city of Toledo, Ohio, is situated at the mouth of the Maumee River. The Maumee River empties into Maumee Bay at a point, by way of the channel, about 7 miles from the deep water of Lake Erie. A history of the operations carried on in past years for the improvement of this harbor will be found in the Annual Reports for 1880 and 1881.

The attention of Congress was first called to this work in 1866, when an examination of the harbor showed a good depth in the river, but through the bay the channel was intricate, presenting a depth of only 11 feet for over a mile, and so narrow that vessels could not navigate without grounding upon adjacent shoals. The work of improvement was commenced in 1867, and has been continued from time to time since that date, dredging in the natural channel between the mouth of the river and deep water in the lake, and at the close of the present fiscal year there was a good channel between Toledo and the lake from 250 to 350 feet wide at the angles, with a depth of from 15 to 17 feet at ordinary low water.

This channel has been obtained and maintained by fifteen appropriations, averaging \$45,646.67, and an annual average expenditure of about

of about \$30,000 to keep the depth required, which depth will doubtless have to be increased from period to period by the demands of commerce.

The present project, adopted in 1872 and amended in 1880 so as to gain increased depth, provides for widening to 250 feet at surface and 200 feet at bottom, and deepening to 16 feet at low water the natural channel through Maumee Bay.

OPERATIONS DURING THE PRESENT FISCAL YEAR.

Dredging under contract of May 18, 1881, was in progress at the commencement of the fiscal year, and was continued until September 30, 1882 (the time for completion having been extended to December 1, 1882), when it was completed and closed. By act of August 2, 1882, the sum of \$50,000 was appropriated for this harbor. In October, 1882, a contract was executed with E. H. French, of Fulton, N. Y., for the removal of 200,000 cubic yards of material for continuing the deepening and widening of the channel through Maumee Bay. Operations under this contract were begun April 25, 1883, and were in progress at close of the fiscal year.

During the fiscal year, under the above two contracts, 229,070 cubic yards of material were removed by dredging from the channel through Maumee Bay.

During July, August, and September, 1882, the work was upon "Can Range," upon the "Turtle Island Range," and some little upon the "Manhattan" and "Middle Ranges."

The portions worked over were left with an average depth of 15½ feet, and in good shape, excepting 800 feet of "Turtle Island Range." The dredged ranges were all 200 feet in width, and 250 feet to 350 feet at the turns. These ranges had all been filled in from 1 to 2 feet, more or less, during the winter of 1881, 1882, and the spring of 1882. At the close of the season of 1882 the condition of the channel was as follows:

First. From the Toledo docks to the Manhattan or inner range, there was a good wide channel with a least depth of 17 feet.

Second. The Manhattan Range, 2,900 feet long, had a width of from 200 to 280 feet at bottom, with a depth of 15½ feet and over.

Third. The Middle Range, 2,860 feet long, had a width of 200 feet at bottom, with an average depth of 15½ feet, with spots of only 14½ feet.

Fourth. The outer or Phenstock Range, 5,055 feet long, had a width of 200 feet at bottom, with an average depth of 15 feet, with 14 feet at the sides.

Fifth. The Can Range, 11,580 feet long, had an average depth of 15½ feet, with 14 to 15 feet at the sides, its width for 8,780 feet was 200 feet, and for the remaining 2,800 feet was 150 feet at bottom.

Sixth. The Turtle Island Range, 9,790 feet long, with a width of 220 feet, had a depth of from 15 to 17 feet.

Seventh. The outer or Lake Range, running to 16 feet water in the lake, with a length of 7,800 feet, and width of 200 feet at bottom, had a depth of from 14½ to 16 feet. During part of April, May, and all of June, the work was upon the Middle Range and upon the Phenstock Range, from which 121,525 cubic yards of material were dredged with three dredges in an average of forty-eight working days. The parts worked over were left with full 16½ feet of water, 200 feet in width and 250 to 350 feet in width on the turns. During the summer and fall of 1882, and spring and summer of 1883, more or less delay arose from storms, breaking of machinery, &c., so that in the months

r 57 per cent. of the time engaged, estimating twelve working hours or each day (excluding Sundays), while in April, May, and June of 1883, the three dredges were employed dredging fourteen hundred hours or 80 per cent. of the time engaged, estimating twelve working hours or each day (excluding Sundays). This latter showing is unusually favorable. During the season of 1883 it is proposed to continue operations so far as the contract of October 9, 1882 will allow. I quote from Maj. J. M. Wilson's last annual report (the then officer in charge) regarding the increased dimensions of lake vessels:

In 1841 the capacity of the largest vessel on the lakes was 4,500 bushels of grain; in 1872 this had been increased to 25,000 bushels, while in 1882 there were several carrying 100,000 bushels.

The capacity of the Onoko, a magnificent iron vessel, launched at Cleveland, Ohio, in the spring of 1882, is 100,000 bushels of grain, or 3,000 gross tons of iron ore.

I am informed that a sailing vessel is now being constructed at Milan, Ohio, which will carry 125,000 bushels of grain on a draught of 15½ feet. It will thus be seen why it is that harbors which gave satisfaction with a depth of 12 feet water twelve years ago now require a full depth of 17 feet.

Attention is again called to the urgent need of day-bacons and range lights for the channel through Maumee Bay.

The present systems of can-buoys and spars do not answer the needs of vessels. They are continually being torn away or pushed aside by rafts and other craft, so that the channel is half the time without sailing marks, and of course are of no use of dark nights.

There should be some system of permanent beacons and range lights. The cost would be small as compared with the great benefit. The total amount appropriated for this harbor since 1866 has been \$684,700, of which sum \$640,972.27 has been expended. The estimated cost of the present project, viz, a channel with a least depth of 16 feet at ordinary low water, and 250 feet in width at surface, was \$570,000. Of this amount \$490,000 has already been appropriated. The balance of \$80,000 can be expended during the period ending June 30, 1885, in deepening and widening channel between Toledo and deep water in Lake Erie.

The amount of commerce to be benefited is very large and constantly growing in importance. Attention is called to statistics of commerce for six years (1875 to 1880) published in Annual Report of 1881.

Toledo is in the collection district of Miami. There is a fixed white light of the fourth order on Turtle Island, and three sets of range lights for parts of the channel.

The amount of revenue collected during eleven months ending May 31, 1883, was \$17,133.96. The value of the imports was \$35,338.65.

The collector of customs failed to state value of the exports.

One thousand six hundred and seventy-one vessels, with an aggregate tonnage of 599,823 tons, entered, and 1,631 vessels, with an aggregate tonnage of 584,367 tons, cleared during eleven months ending May 31, 1883. The largest cargo that cleared was 2,200 tons of coal, the vessel drawing 15 feet.

Money statement.

July 1, 1882, amount available.....	\$22,669 17
Amount appropriated by act passed August 2, 1882	50,000 00
	<hr/> 72,669 17
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$28,941 44
July 1, 1883, outstanding liabilities	908 55
	<hr/> 29,849 99
July 1, 1883, amount available.....	<hr/> 42,819 18
Amount (estimated) required for completion of existing project	80,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	80,000 00

No.	Names and addresses of bidders.	Price.	Remarks.
1	Edwin H. French, Fulton, N. Y.	<i>Per cu. yd.</i> \$0 21	Contract awarded subject to approval of the Chief of Engineers.
2	Louis P. Smith and James A. Smith, Cleveland, Ohio.	22	
3	James Rooney, Toledo, Ohio	24	

Abstract of contracts for improving harbor at Toledo, Ohio, in force during fiscal year ending June 30, 1883.

Names and addresses of contractors.	Date of contracts.	Subject of contract.	Mud, sand, clay, &c., per cubic yard in scows.	For the removal from the channel of the Maumee River, Toledo, Ohio, the wreck of the scow Wellhouse, its equipment and cargo.	Remarks.
Symmes & Scandlon, North East, Pa.	May 18, 1881	Dredging	\$0. 15	.....	Contract completed and closed September 30, 1882.
S. A. Murphy, Detroit, Mich.	Jan. 12, 1882	Removal of scow Wellhouse, its equipment and cargo.	.....	\$1, 750	Contract completed and closed July 10, 1882.
Edwin H. French, Fulton, N. Y.	Oct. 9, 1882	Dredging	21	.....

K K 3.

IMPROVEMENT OF PORT CLINTON HARBOR, OHIO.

Port Clinton, Ohio, is situated at the mouth of the Portage River, a stream which rises in the northwestern part of Ohio and empties into Lake Erie.

A history of the operations heretofore carried on for its improvement will be found in Annual Reports of 1880 and 1881.

The present project, adopted in 1875, consists of a pile revetment 967 feet long, running from the north shore of Portage River, opposite the town, out into the lake in a direction north 57 degrees east. This revetment then inclines toward the north and extends 301 feet further, when a pile-dike commences, which will be prolonged a total distance of 1,200 feet out to a depth of 10 feet at the ordinary level of the lake. Parallel to this and 200 feet from it is an east pile-pier, which will be about 2,600 feet long, its inner end resting on the south shore of the river. This east pier will be a simple pile structure of 2,450 feet; the outer 150 feet will be a strong pile-dike 12 feet wide. A channel 10 feet deep will be dredged between the piers.

At the beginning of the fiscal year there was no work in progress, and **alance** was too small to attempt any new work.

By act of August 2, 1882, the sum of \$6,000 was appropriated for his harbor.

A contract was executed with John Stang, of Lorain, Ohio, dated September 12, 1882, for the construction of 150 linear feet of pile-pier or prolonging the west pier, and the construction of 250 linear feet of pile revetment for prolonging the east revetment. Piles and other materials were delivered during the fall of 1882, but actual construction was not commenced until May 31, 1883, and has been in progress since that date to the close of the fiscal year. Considerable delay was experienced on account of stormy weather and from the fact that the piles, delivered as per specifications, were found to be too short, owing to the soft character of the lake bottom at end of piers. An extension of the time for completing the contract had to be asked for by the contractor, and was granted by the Chief of Engineers.

During May and June the contractor furnished, drove, and cut off one hundred and ninety-five piles, making 4,934 linear feet. The sum of \$829.36 has been expended during the fiscal year.

During the season (1883) it is proposed to complete the work under contract of September 12, 1882, and to make some repairs to west pier and to the east revetment. The piers at their commencement are 600 feet apart, but converge, and when a point about 1,000 feet from shore is reached they become 200 feet apart and then continue parallel. They will be extended to a depth of 10 feet at the ordinary stage of the lake. The estimated cost of the present project, as submitted in 1875, was \$122,000, revised estimate for \$90,000; of this amount \$46,000 has been appropriated and \$40,004.83 expended up to the close of the fiscal year ending June 30, 1883. The commerce of Port Clinton is small and the prospects for a considerable increase are not very great. Lumber, staves, spokes, &c., are the principal articles of shipment.

It is therefore doubtful whether the expenditure of the remaining \$44,000 for the completion of the proposed project as revised would be advisable. If it is decided to continue the improvement as proposed, the sum of \$20,000 can be expended during the period ending June 30, 1885, in prolonging the pier and revetment.

At the close of the fiscal year there was a good channel from lake and within the piers with a least depth of 9 feet.

During the present season it is proposed to complete the work required under contract of September 12, 1883, and make some repairs to west pier.

Port Clinton is a port of entry in the collection district of Sandusky, Ohio. The nearest work of defense is Fort Wayne, 60 miles distant, and the nearest light-house is at Green Island, 10 miles distant.

The amount of commerce to be benefited by this improvement is small; for miles above the mouth of Portage River, and bordering upon its banks, are extensive tracts of hard-wood timber, from which lumber, staves, spokes, &c., are made and sent to Port Clinton for shipment.

The amount of revenue collected during eleven months ending May 31, 1883, was \$132.20.

The value of the imports was \$1,440.

There were no exports to points outside the district. Twenty-seven vessels, with an aggregate tonnage of 1,660 tons, entered, and twenty-eight vessels, with an aggregate tonnage of 1,740 tons, cleared during eleven months ending May 31, 1883.

1894 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Money statement.

July 1, 1892, amount available.....	\$824 53
Amount appropriated by act passed August 2, 1892.....	6, 000 00
	<hr/> 6, 824 53
July 1, 1893, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1892.....	629 36
July 1, 1893, amount available.....	<hr/> 5, 995 17
Amount (estimated) required for completion of existing project.....	44, 000 00
Amount that can be profitably expended in fiscal year ending June 30, 1895.....	20, 000 00

Abstract of proposals for prolonging the piers at Port Clinton Harbor, Ohio, received and opened by Maj. John M. Wilson, Corps of Engineers, at United States Engineer office, Cleveland, Ohio, at 11 o'clock a. m., Tuesday, September 5, 1892, under advertisement of August 10, 1892.

Materials.	1. John Stang, Lorain, Ohio.	2. Courtland D. Merry, Painesville, Ohio.	3. Alphonse Concha, Port Clinton, Ohio.*
White-oak piles, 10,800 linear feet, more or less:			
Per linear foot, including driving	\$0 21	\$0 30	\$0 22
Total	2, 268 00	3, 240 00	2, 376 00
White-oak timber and plank, 42,794 feet, B. M., more or less:			
Per 1,000 feet, B. M., including sheathing piles and their driving	35 00	33 00	32 00
Total	1, 487 79	1, 412 00	1, 389 42
Fascines and mattresses of brush or mill clippings, 90 cords, more or less:			
Per cord	2 50	1 25	2 00
Total	225 00	112 50	180 00
Stone filling, 100 cords, more or less:			
Per cord	4 25	5 25	4 50
Total	425 00	525 00	450 00
Stone riprap, 100 cords, more or less:			
Per cord	4 25	5 25	4 50
Total	425 00	525 00	450 00
Rods, 1,770 pounds, more or less:			
Per pound	04½	05	04½
Total	75 22	88 50	78 75
Screw-bolts, 2,700 pounds, more or less:			
Per pound	04½	05	04½
Total	114 75	135 00	123 75
Drift-bolts, 82 pounds, more or less:			
Per pound	03	04	03
Total	2 46	3 28	2 46
Wrought spikes, 1,410 pounds, more or less:			
Per pound	03½	05	03½
Total	52 87	70 50	48 37
Total amount of bid	<hr/> 5, 086 09	<hr/> 6, 111 98	<hr/> 5, 220 25

* Proposal thrown out as it contained no bid for iron.

Contract awarded to John Stang, dated September 12, 1892.

K K 4.

IMPROVEMENT OF SANDUSKY CITY HARBOR, OHIO.

Sandusky Bay empties into Lake Erie about 40 miles from its western extremity. It is a natural harbor, containing an area of about 22½ miles, with a depth of from 8 to 12 feet, protected on the north and northwest from the gales of the lake by a long, narrow peninsula, and on the north-

The present project, adopted in 1880, provides for a channel 200 feet wide and 15 feet deep through the outer bar, and in the bay up to within 50 feet of the line of docks, and then parallel to the docks, with a width of 100 feet and depth of 15 feet.

OPERATIONS DURING THE FISCAL YEAR.

The balance on hand at beginning of the year (\$1,201.52) was considered too small to begin any new work. By act of August 2, 1882, the sum of \$10,000 was appropriated for this harbor. Proposals for dredging were invited, and in September, 1882, a contract was executed with William Richardson, of Buffalo, N. Y., for widening and deepening the channel by the removal, by dredging, of 70,000 cubic yards of material. Operations were commenced September 21, and continued till November 25, 1882, when on account of stormy weather the dredge-boats were withdrawn for the season.

Operations were resumed May 1, and were in progress at the close of the fiscal year.

The operations resulted in the completing of a channel 4,680 feet in length by 100 feet in width, with least depth of 15 feet, all parallel to "line of docks"; the entrance from this channel to "Clock Range Channel" has been deepened to 15 feet and widened from 200 to 1,000 feet. Work on this portion is completed so far as present contract is concerned. In performance of this work 60,000 cubic yards were removed from channel parallel to city docks and the "Clock Range." There remains 10,000 cubic yards to be removed from off "the outer bar" to complete this part of the contract, when there will be a good channel with least depth of 15 feet, requiring however to be widened to full width of 200 feet. The total amount appropriated for this harbor to the present time has been \$245,080 of which sum \$241,051.99 has been expended. It is estimated that \$30,000 will be required to complete the present project, the whole of which can be expended during the period ending June 30, 1885, in deepening and widening channel through the outer bar and removing such deposits from other parts of the channel as may occur from time to time.

With an increase of commerce at Sandusky, an increase to 16 feet in depth of water will be required to correspond with other important harbors on Lake Erie and with the depth now carried through the "Saint Clair Flats Canal."

This increased depth Major Wilson estimated would cost \$61,000 additional, making \$91,000 required for this harbor, of which sum \$60,000 can be expended by the close of the fiscal year ending June 30, 1885.

Like Toledo and other harbors where a dredged channel is the method of improvement the expenditure must be a large one annually, and the work each year has to be done anew, as it were, for the storms of winter and spring wash into the channel a large percentage of the material that was removed during the past season.

Sandusky City Harbor is in the collection district of Sandusky, Ohio; there is a light-house on Cedar Point, with a fixed white light of the fifth order, and three range lights within the bay. Fort Wayne, below Detroit, is the nearest work of defense.

The amount of revenue collected during eleven months ending May 31, 1883, was \$6,345.

The value of the foreign imports was \$38,015, and of the foreign exports, \$43,109.

1896 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

I was unable to learn the value of the domestic imports and exports. The imports consisted of—

Iron ore	gross tons..	31,909
Anthracite coal	do.....	10,529
Lumber	feet..	50,572,000
Laths	number..	7,317,000
Shingles	do.....	1,824,000
Corn	bushels..	68,915
Wheat	do.....	558,925
Merchandise	tons..	2,000

The exports consisted of—

Coal	gross tons..	58,874
Steel rails	do.....	12,000
Merchandise	tons..	2,000

The number of vessels entered was seven hundred and seventy-six, with an aggregate tonnage of 179,352 tons; seven hundred and seventy-two vessels, with an aggregate tonnage of 183,209 tons, cleared during the eleven months ending May 31, 1883.

The largest cargo that entered was 1,529 gross tons of iron ore, the vessel drawing 15 feet 2 inches; the largest cargo that cleared was 1,709 gross tons of coal, the vessel drawing 15 feet 3 inches.

Money statement.

July 1, 1882, amount available	\$1,201 52
Amount appropriated by act passed August 2, 1882.	10,000 00
	<hr/> 11,201 52
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$7,173 51
July 1, 1883, outstanding liabilities	651 42
	<hr/> 7,824 93
July 1, 1883, amount available	<hr/> 3,376 59
Amount (estimated) required for completion of existing project	30,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	30,000 00
If it is determined to gain a depth of 16 feet, the amount that can be profitably expended during the fiscal year ending June 30, 1885, will be ..	60,000 00

Abstract of proposals for dredging 50,000 cubic yards, more or less, of mud, clay, sand, &c., from the channel parallel to the Sandusky Docks and the outer bar between the city front and the curve of 15 feet in the lake at Sandusky Harbor, Ohio, received and opened by Maj. John M. Wilson, Corps of Engineers, at United States Engineer office, Cleveland, Ohio, at 11 o'clock a. m., Tuesday, September 5, 1882, under advertisement of August 10, 1882.

No.	Names and addresses of bidders.	Rate.
		<i>Per cu. yd.</i>
1	Jesse Sims, Cleveland, Ohio	\$0 20
2	William Richardson, Buffalo, N. Y.	12
3	James Rooney, jr., Toledo, Ohio	14
4	Louis P. & James A. Smith, Cleveland, Ohio.....	14
5	Edwin H. French, Fulton, N. Y.	14½

Contract awarded to William Richardson, dated September 14, 1882.

The Sandusky River rises in Richland County, Ohio, and after a very circuitous course empties in Sandusky Bay about 14½ miles from Cedar Point, where the bay empties into Lake Erie.

Fremont, the head of navigation, is 17 miles from the mouth of the river. It is a city of about 9,000 inhabitants, and the market place of a large and productive surrounding country. A history of the work carried on in past years for the improvement of the river will be found in Annual Report for 1881.

The present project, adopted in 1880, provides for dredging a channel 100 feet wide and 9 feet deep through the various bars between the city of Fremont and the depth of 9 feet in Sandusky Bay.

Major Wilson, Corps of Engineers, the then officer in charge, in his annual report for 1882, writes as follows:

I am satisfied that but little difficulty will be experienced in keeping open at all times a good channel with a depth of 9 feet between Fremont and the mouth of the river; but the character of the materials composing the outer bar is such that I deem it exceedingly doubtful whether the channel lately dredged through it will remain open for any length of time; I feel sure that no permanent improvement can be maintained without an elaborate system of dikes, the expense of which would not be warranted by the present limited commerce of the port.

OPERATIONS DURING THE FISCAL YEAR.

Balance of appropriation on hand at beginning of fiscal year was \$20.78. By the act of August 2, 1882, the sum of \$4,000 was appropriated for this river. Proposals were invited, and in September a contract was executed with L. P. & J. A. Smith, of Cleveland, Ohio, for removing from the channel near the mouth of Sandusky River, Ohio, and at such other localities between Fremont, Ohio, and the 10-foot curve in Sandusky Bay as the engineer in charge should direct, 25,000 cubic yards of gravel, sand, mud, clay, &c. Operations were commenced September 19 and completed November 8, 1882.

Two thousand feet of the channel dredged during 1881 to 80 feet in width out to the 8½-foot curve in the bay was widened to 100 feet and cut extended to the 9-foot curve, a distance of about 600 feet.

Total amount of material removed, 25,000 cubic yards. At the close of the year's work there was a good channel with least depth of 9 feet at zero of the gauge from Fremont to the lake within the proper limits of the channel, but whether it will remain so without further annual dredging remains to be seen.

The estimated cost of the present project is \$44,000; of this amount \$21,500 has been appropriated; \$10,000 can be expended during the period ending June 30, 1885.

The amount appropriated for the improvement of this river to date is \$51,500, of which sum \$50,871.53 has been expended.

Fremont, the head of navigation, is in the collection district of Sandusky, Ohio. The nearest light-house is at Cedar Point, the entrance to Sandusky Bay. Fort Wayne, near Detroit, Mich., is the nearest work of defense.

I was unable to learn the amount of revenue collected or the value of the imports and exports during the eleven months ending May 31, 1883.

Eleven vessels, with an aggregate tonnage of 2,421 tons, entered, and nine vessels, with an aggregate tonnage of 1,853 tons, cleared during the eleven months ending May 31, 1883.

1898 REPORT OF THE CHIEF OF ENGINEERS, U S. ARMY.

Money statement.

July 1, 1882, amount available.....	\$30 75
Amount appropriated by act passed August 2, 1882.....	4, 000 00
	<hr/> 4, 030 75
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	3, 392 31
	<hr/> 638 44
July 1, 1883, amount available.....	
Amount (estimated) required for completion of existing project.....	22, 500 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	10, 000 00

Abstract of proposals for dredging 18,000 cubic yards, more or less, of mud, clay, sand, &c., from the channel near the mouth of the Sandusky River, and at such other localities between Fremont and the mouth of the river as the engineer in charge shall direct, received and opened by Maj. John M. Wilson, Corps of Engineers, at United States Engineer office, Cleveland, Ohio, at 11 o'clock a. m., Tuesday, September 5, 1882, under advertisement of August 10, 1882.

No.	Names and addresses of bidders.	Rate, measured in cu. yds.
		<i>Per cu. yd.</i>
1	Quartus Gillmore and John Stang, Lorain, Ohio.....	\$0 15
2	William Richardson, Buffalo, N. Y.....	14
3	Jesse Sims, Cleveland, Ohio.....	20
4	James Rooney, Jr., Toledo, Ohio.....	16
5	Louis P. & James A. Smith, Cleveland, Ohio.....	12
6	Edwin H. French, Fulton, N. Y.....	17

Contract awarded to L. P. & J. A. Smith, dated September 14, 1882; completed November 8, 1882.

K K 6.

IMPROVEMENT OF HURON HARBOR, OHIO.

The Huron River rises in the northern part of Ohio, and after a very circuitous course empties into Lake Erie about 10 miles east of Sandusky City. For a history of the operations carried on in past years for the improvement of this harbor see the Annual Reports of 1880 and 1881.

OPERATIONS FOR THE FISCAL YEAR.

In July, 1882, the repairs which had been commenced in May, 1882, were completed. In that month 250 feet (linear) of the old work was torn away and rebuilt, filled with stone and decked anew. Fifteen oak piles (each 25 feet in length) were driven along channel-face of pier. The repairs to superstructure by hired labor cost \$5.50 per linear foot. By the act of August 2, 1882, an appropriation of \$2,500 was made for this harbor.

Proposals were invited, and in September a contract was made with John Stang, of Lorain, Lorain County, Ohio, for renewing 200 feet, more or less, of the outer portion of the east pier.

Under this contract the old superstructure upon 182 feet (linear) of the east pier was removed from four to six courses down and rebuilt with

new materials, and minor repairs made to part of the pier under water. Contract completed and closed in October.

The storms of this winter and spring caused considerable damage to the east pier and to the beach adjoining said pier. As the repairs were needed at once, authority was granted to make same "by hired labor and purchase in open market."

Work was begun in April and completed by June 4, 1883. The balance of appropriation on hand was too small to make even the necessary temporary repairs, and the case being an urgent one and of importance to the interests of Huron, a subscription of \$500 was made by the citizens of the place and tendered to the United States for repairs to pier. This sum was accepted by the honorable the Secretary of War, who directed its expenditure be made under the direction of the engineer in charge, and it was so expended.

With the whole amount expended, about \$1,400, the pier and beach were only partially repaired, and a further sum is very necessary to further protect the beach and shore end of pier from further storms and prevent a serious breach between inner end of pier and the land.

The following amounts of materials were used during the fiscal year:

IN REPAIRS BY HIRED LABOR.

White-oak piles.....linear feet..	2,621	{	1,550 feet new.
White-oak timber.....feet B. M..	6,304	{	1,071 feet donated.
Pine timber	52,696	{	50,490 feet new.
Pine planks	15,676	{	2,206 feet old.
Screw and washer-bolts	420	{	12,906 feet new.
Drift-bolts	3,318	{	2,770 feet old.
Rods	215	{	1,839 pounds new.
Spikes	400	{	1,479 pounds old.
Brush	15	{	10 cords new.
Stone	88	{	5 cords donated.
			28 cords donated.
			60 cords taken from old works.

IN REPAIRS BY CONTRACT.

White-pine timber.....feet, B. M..	35,820
White-pine plank.....do....	8,916
White-oak timber.....do....	866
Drift-bolts.....pounds..	2,382½
Spikes.....do....	550
Stone for filling.....cords..	30

The entire amount appropriated to date for this harbor has been \$106,773.71, and of this amount \$106,728.08 has been expended, by which expenditure the depth of water at entrance of river has been gradually increased from zero to 15 feet at low water. The present project contemplates the renewal of the superstructure of both piers at an estimated cost of \$22,000; of this sum \$6,000 has already been appropriated and expended, and the sum of \$16,000 can be expended during the period ending June 30, 1885, in rebuilding superstructure of piers and repairing portion of same under water.

As Huron is one of the best natural harbors on Lake Erie, it will be proper, if the commerce of Huron increases as it is expected to do, to extend the piers out to a depth of 16 feet in the lake. The records of the custom-house show that at present the amount of commerce benefited by the improvement made at this harbor is very small.

tion of slips and docks with view to an extensive business.

Huron Harbor is in the collection district of Sandusky, Ohio. Fort Wayne, Mich., about 70 miles distant, is the nearest work of defense. There is a fixed white light of the fourth order on the outer end of the west pier. During the eleven months ending May 31, 1883, there was no revenue collected.

The imports in the same period were one vessel load of cord-wood from Canada, valued at \$90. The exports consisted of 535 tons of coal, valued on the dock at \$1,392.

Twenty-eight vessels, with aggregate tonnage of 4,541 tons, were entered, and twenty-four vessels, with aggregate tonnage of 5,078 tons, were cleared.

The deputy collector reports that the greater part of the larger vessels doing business at Huron are engaged within the limits of the customs district, and are not obliged to enter or clear, hence are not recorded at the office.

Money statement.

July 1, 1882, amount available	\$2, 231 58
Amount appropriated by act passed August 2, 1882	2, 500 00
	<hr/> 4, 731 58
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	4, 685 95
	<hr/> 45 63
July 1, 1883, amount available.....	
Amount (estimated) required for completion of existing project.....	16, 000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	16, 000 00

Abstract of proposals for tearing down the old superstructure and replacing it with new materials upon a length of 200 linear feet, more or less, of the east pier at Huron Harbor, Ohio, received and opened by Maj. John M. Wilson, Corps of Engineers, at United States Engineer office, Cleveland, Ohio, at 11 o'clock a. m., Tuesday, September 5, 1882, under advertisement of August 10, 1882.

	1. John Stang, Le-rain, Ohio.	2. Courtland D. Mor- ry, Palmyra, Ohio.	3. Charles Limbach and Mack Cohen, Vermilion, Ohio.
Materials.			
Pine timber and plank, 58,513 feet, B. M., more or less:			
Per 1,000 feet.....	\$33 00	\$32 00	\$40 00
Total.....	1, 930 93	1, 872 42	2, 340 32
White-oak timber snubbing-posts, 505 feet, B. M., more or less:			
Per 1,000 feet.....	35 00	32 00	40 00
Total.....	17 67	16 16	20 29
Drift-bolts, 3,140 pounds, more or less:			
Per pound.....	03	05	06
Total.....	94 20	157 00	125 00
Ship or boat spike, 400 pounds, more or less:			
Per pound.....	03	05	05
Total.....	12 00	20 00	20 00
Stone filling, 30 cords, more or less:			
Per cord.....	4 25	15 00	6 00
Total.....	127 50	450 00	180 00
Total amount of bid.....	2, 182 80	2, 515 58	2, 686 33

Contract awarded to John Stang dated September 12, 1882; completed October 18, 1882.

K K 7.

IMPROVEMENT OF VERMILLION HARBOR, OHIO.

The Vermillion River rises in the northern part of Ohio and empties into Lake Erie about 20 miles to the eastward of Sandusky City.

A history of the operations carried on in past years for the improvement of this harbor will be found in Annual Reports of 1880 and 1881.

The project of improvement, which was adopted in 1836, when there was a depth of less than 2 feet of water on the bar at the entrance, and which project has been amended from time to time, as the requirements of commerce demanded deeper water, consists of parallel piers 125 feet apart running out to a depth of 12 feet in the lake.

OPERATIONS FOR THE FISCAL YEAR.

There were no funds on hand at the beginning of the fiscal year. By the act of August 2, 1882, the sum of \$3,000 was appropriated for this harbor. Repairs to piers "by hired labor and purchase in open market" were begun in August, 1882, and completed in September. Repairs consisted in building a crib and sinking it in a hole in the west pier, about 20 feet from the outer end, which had been made by furious gales in April, 1882, and in renewing broken plank and deck-joint on both piers. In the performance of this work the following materials were used :

Pine timber.....	feet, B. M.	6,494
Pine plank.....	do.	7,095
Iron.....	pounds..	117
Spikes (new).....	do.	200
Spikes (old).....	do.	700
Drift-bolts (old).....	do.	150
Stone.....	cords..	5

This left the piers in comparatively good condition, so that no further operations were necessary during remainder of the year.

It is proposed during the season of 1883 to expend the remaining balance of appropriation, \$2,507.66, in repairs to piers and dredging.

The proposed project for this harbor provides for opening a channel 100 feet wide and 14 feet deep from the lake to the lower end of the stone docks in the river, by removing about 2,000 cubic yards of rock and about 25,000 cubic yards of sand, gravel, and shale, at an estimated cost of \$15,000. The piers also need considerable repairs, estimated to cost \$2,000, making a total of \$17,000 required for the project.

Major Wilson, Corps of Engineers, the then officer in charge, in his last annual report for this harbor, writes :

The sand is slowly but steadily moving around the ends of the piers into the channel. In order to arrest its progress and maintain a depth of 14 feet at the entrance, it will be necessary to extend both piers 500 feet into the lake, at a cost of \$70,000.

I do not think that the present limited commerce of Vermillion will justify me in suggesting so great an expenditure at this time.

With this view of the case, it is doubtful whether the expenditure of the required \$14,000 is advisable. The total amount appropriated for this harbor to date is \$114,942.32, of which sum \$112,434.66 has been expended.

Vermillion Harbor is in the collection district of Sandusky, Ohio. There is a fixed white light of the fifth order on the west pier.

Fort Wayne, Mich., 80 miles distant, is the nearest work of defense.

The amount of revenue collected during eleven months ending May 31, 1883, was \$19.50.

1902 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Thirty vessels, with an aggregate tonnage of 4,441 tons, entered, and thirty-two vessels, with an aggregate tonnage of 2,626 tons, cleared during eleven months ending May 31, 1883.

I was unable to learn the value of the imports and exports.

The imports consisted of the following: 1,505,000 feet of lumber.

The exports were as follows: 30,000 staves, 7,527 bushels of grain, and 110 tons of stone.

Money statement.

Amount appropriated by act passed August 2, 1882.....	\$3,000 00
July 1, 1883, amount expended during fiscal year.....	492 34
July 1, 1883, amount available.....	2,507 66
Amount (estimated) required for completion of existing project.....	14,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885..	14,000 00

K K 8.

IMPROVEMENT OF HARBOR AT MOUTH OF BLACK RIVER, OHIO.

Black River, Ohio, is formed by two branches nearly equal in size, which, rising in Lorain County, Ohio, and flowing northward, unite about 8 miles from the town of Lorain, where the river empties into Lake Erie.

A history of the operations carried on during the last fifty-four years, whereby the depth at the entrance to this harbor has been increased from about 3 to at least 16 feet, will be found in Annual Reports of 1880 and 1881.

The project of improvement submitted in 1828, and amended from time to time as the demands of commerce called for an increased depth in the channel, consists of parallel piers, 200 feet apart, running out from the shore on each side of the mouth of the river to a depth of 16 feet in the lake.

OPERATIONS DURING THE FISCAL YEAR.

There was no work in progress at the beginning of the fiscal year.

By act of August 2, 1882, the sum of \$7,000 was appropriated for this harbor.

In the months of August, September, and October some repairs were made to the piers where necessary "by hired labor and purchase in open market."

In October a contract was executed with John Stang, of Lorain, Ohio, dated October 16, 1882, for renewing 300 linear feet more or less of the east pier, renewing 627 linear feet more or less of the west pier, for making repairs to piers under water, and to replace in good condition on the pier, after its renewal, 480 linear feet, more or less, of the elevated walk (for light-keeper's use).

This contract was modified by further articles of agreement dated March 29, 1883, in order to cover repairs to piers and pile revetment, which were made necessary from damage done by storms of February, 1883. In the repairs by hired labor the following materials were used:

Pine timber.....	feet, B. M..	30
Oak timber.....	do.....	120
Pine plank (new).....	do.....	1,961
Pine plank (old).....	do.....	77
Piles.....	linear feet..	1,248
Drift-bolts.....	pounds..	65
Screw bolts.....	do.....	75
Spikes (new).....	do.....	117
Spikes (old).....	do.....	8

the outer end of the east pier, and to protect the angle of east pier on the lake side. The piles were connected with cap piece or waling pieces, which were in turn bolted to pier timbers. The deck plank were also renewed.

These repairs put the piers in fair repair, but extensive repairs and renewals were needed as provided for under contract of October 16, 1882.

In February, 1883, a severe storm and freshet with ice gorge did considerable damage at this harbor; about 200 linear feet of the east pier and 75 linear feet of the pile protection, built in 1881, were badly wrecked. As the damage was serious, requiring early attention and considerable expense, it was thought best to have the contractor for work in 1883 make the repairs, which suggestion was approved by the Chief of Engineers, and contract of October 16, 1882, was accordingly modified to embrace said repairs.

The work under contracts was not commenced until May 29, 1883, owing to the unfavorable spring weather, and at the close of the fiscal year was in full progress.

By the end of June the old pile revetment needing repair had been torn down, three-fourths of the piles for new revetment had been driven and cut off, about 428 linear feet of the west pier had been torn down to 1 foot below ordinary low water, preparatory to renewal, and about one-fourth of the superstructure of west pier replaced with new material.

The following materials were expended in this work :

Pine timber	feet, B. M.	26, 170
Pine plank	do.	370
Oak piles	linear feet.	1, 941
Drift-bolts (new)	pounds.	1, 608
Drift-bolts (old)	do.	848
Ship spikes (old)	do.	13

During the fiscal year the sum of \$821.87 was expended; of this \$534.68 was for repairs by hired labor, and \$287.19 was for contingent expenses pertaining to contract work.

The present project provides for prolonging the west pier 180 feet, and the east pier 120 feet, and for renewing about 2,000 linear feet of superstructure, at an estimated cost of \$45,000. Of this amount \$17,000 has already been appropriated, and the balance of \$28,000 can be profitably expended during the period ending June 30, 1885, in prolonging piers and renewing superstructure.

During the present season it is proposed to complete the work under contract of October 16, 1882, and its modification of March 29, 1883. To the end of the fiscal year ending June 30, 1883, the sum of \$190,138.73 has been appropriated for this harbor, of which amount \$181,011.12 has been expended, with which a channel with least depth of 16 feet has been obtained.

Black River is in the collection district of Cuyahoga, Ohio; the commerce is increasing, and the harbor is destined to take high rank with the others on the lakes. Its trade in coal and iron is daily becoming more valuable; it is the lake terminus of the Cleveland, Tuscarawas and Wheeling Railroad, which has direct connection with the Ohio River; at present vessels drawing 15½ feet can enter the harbor at all times. There is a fixed white light of the fourth order at the outer end of the west pier; the nearest work of defense is Fort Wayne, Mich., 80 miles distant.

The amount of revenue collected during eleven months ending May 31, 1883, was \$807.33.

The value of the imports was \$625,722, and of the exports \$197,310, during the year ending December 31, 1882.

The largest cargo that entered was 1,470 gross tons of iron ore, the vessel drawing 14 feet.

Money statement.

July 1, 1882, amount available.....	\$2,949 48
Amount appropriated by act passed August 2, 1882.....	7,000 00
	<hr/> 9,949 48
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	821 87
	<hr/> 9,127 61
Amount (estimated) required for completion of existing project.....	28,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885..	28,000 00

Abstract of proposals for tearing down the old superstructure and replacing it with new materials upon 300 feet, more or less, of the east pier, and of 627 feet, more or less, of the west pier, and minor repairs to the work under water, at Black River Harbor, Ohio, received and opened by Maj. John M. Wilson, Corps of Engineers, at United States Engineer Office, Cleveland, Ohio, at 11 o'clock a. m., Thursday, October 5, 1882, under advertisement of September 5, 1882.

Materials.	John Stang, Lorain, Ohio.	
	Rate.	Total.
White-pine timber and plank, 227,450 feet, B. M., more or less .per M feet, B. M.	\$32 75	\$7,448 00
White-oak timber, 15,794 feet, B. M., more or less .do.	34 00	536 00
Drift-bolts, 1,500 (12,300 pounds), more or less .per pound.	03	300 00
Ship or boat spikes, with large heads, 1,400 pounds, more or less .do.	04	56 00
Stone for filling, 180 cords, more or less .per cord	4 50	810 00
Taking down and rebuilding elevated walk on 480 linear feet .per linear foot.	40	192 00
Total		<hr/> \$8,412 00

Contract awarded, subject to approval of Chief of Engineers.

Abstract of contract for improving harbor at Black River, Ohio, in force during fiscal year ending June 30, 1883.

Materials.	John Stang, Lorain, Ohio.	
	Contract. Oct. 16, 1882.	Modified Mar. 9, 1883.
White-pine timber and plank .per M feet, B. M.	\$32 75	\$32 75
White-oak timber .do.	34 00	34 00
White-oak timber and plank .do.		34 00
White-oak piles .per linear foot, including driving.		35
White-oak sheathing piles .do.		40 00
Brush for protection at foot of piles .per cord of 128 cubic foot.		2 50
Stone for filling .do.	4 50	
Stone for filling cribs or for riprapping .do.		4 50
Screw and washer bolts .per pound.		05
Drift-bolts .do.	03	05
Spikes .do.	04	
Wrought spikes .do.		04
Taking down or rebuilding or bracing up elevated walk .per lin. ft. of walk.	40	

Rocky River rises in the northern part of Ohio, and, flowing north, empties into Lake Erie about 5 miles west of Cleveland.

A history of the operations heretofore carried on at this place under various acts of Congress will be found in the Annual Reports of the Chief of Engineers for 1880 and 1881.

At the close of the calendar year 1882 this pier was in fair order; some minor repairs were alone needed. During the months of February and March, 1883, the violent storms and freshets forced a new channel around the inner end of the pier and undermined and carried away about 100 feet of the crib-work, seriously damaging the work. This will be repaired early this season—say in August, 1883.

There was no work done during the fiscal year at this harbor. It is not proposed to do any further work at this place other than to keep the pier in order as far as available funds will admit.

Rocky River is not a port; it has no commerce, and unless a large amount is expended for its improvement it can never be used as a harbor for the large vessels now navigating the lakes.

The General Government is now constructing a large harbor of refuge at Cleveland, only 5 miles distant.

No further appropriation is required at present. The total amount appropriated for the river mouth up to the present time has been \$39,000, of which sum \$37,414.69 has been expended.

The nearest light-house is at Cleveland. The nearest work of defense is at Fort Wayne, Mich., 106 miles distant.

Money statement.

July 1, 1882, amount available	\$1,586 37
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	1 06
July 1, 1883, amount available	1,585 31

K K 10.

IMPROVEMENT OF CLEVELAND HARBOR, OHIO.

Cleveland, Ohio, is situated at the mouth of the Cuyahoga River. This river rises in the northern part of Ohio and, after a very circuitous course, empties into Lake Erie. A description of the operations carried on in past years for the improvement of this harbor will be found in annual reports of 1880 and 1881.

The original project of improvement adopted in 1825, when there was a depth of only 3 feet in the narrow and crooked channel at the entrance, and which project has been amended from time to time, as the demands of commerce called for an increased depth of water, provides for parallel piers, 200 feet apart, running out to a depth of 16 feet in the lake.

In 1875, in accordance with an act of Congress, a plan was submitted for a harbor of refuge at this place.

This plan, which, after amendment by the Chief of Engineers, was approved by the Secretary of War, provides for an outer breakwater in a depth of about 5 fathoms, connected at its west end with the main shore; the entrance, near the east end, is to be protected by extending the east pier at the mouth of the river.

the lake, in a direction nearly at right angles, a distance of 1,000 feet long, and at a point about 200 feet from its eastern extremity a spur 100 feet long will run out at right angles, so as to break the force of the heavy sea rolling along the breakwater during westerly and north-westerly gales. The east pier at the mouth of the Cuyahoga River will be extended 1,400 linear feet.

The original project of the Board of Engineers provided for prolonging the west pier, but such earnest protests were made against this by parties interested in commerce, and such urgent appeals made for the extension of the east pier instead, that the honorable Secretary of War, before whom these facts were placed, decided to comply with the wishes of the mariners, and has directed that the east, instead of the west, pier shall be prolonged.

OPERATIONS DURING THE PRESENT FISCAL YEAR.

The storms of the winter and spring of 1883 did some damage to the piers at the mouth of the Cuyahoga River, and together with the use and abuse of the piers by vessels "tying up" to and using them (not authorized or allowed, but long usage and custom have made it difficult to prevent it), made considerable repairs necessary this season.

Five hundred and thirty-eight linear feet of broken and rotted wal-ing-strips were removed and replaced with new material on channel face of the piers.

A number of broken planks were replaced with new plank, and slight repairs made to the United States boat-house. In these repairs the sum of \$726.06 was expended.

The following materials were used :

Pine plank (new).....	feet, B. M.	2,223
Pine timber (old).....	do...	216
Oak timber.....	do...	4,464
Screw and washer bolts (new).....	pounds..	1,949
Screw and washer bolts (old).....	do...	373
Screw bolts (old).....	do...	349
Washers (new).....	do...	59
Nuts (new).....	do...	35
Iron.....	do...	11
Drift-bolts (new).....	do...	891
Rods (old).....	do...	16
Spikes (new).....	do...	200

Further, the freshets and ice-gorge in February, 1883, caused a large deposit of materials between the piers, near their outer end, and in lake just beyond piers. This deposit or bar had a least depth of but 13 feet of water on it, and was the source of considerable annoyance to vessels entering the river.

As the need of relief was urgent, application was made to have the material removed by agreement on the best terms practicable by dredging, without waiting for advertisement and regular contract. This method was approved by the Chief of Engineers, and an agreement was made with J. Louis Linn, of Erie, for the removal of about 14,000 cubic yards, at 25 cents per cubic yard. Operations were begun June 9, and by the close of the year about 4,000 cubic yards had been removed from off the outer bar and from channel between the piers. The progress was slow and unsatisfactory, owing to an inadequate dredge. The dredge has been changed, and it is expected that the excavation required will

least depth of 17 feet, and both piers in good repair on portions of breakwater controlled by the United States. In connection with the dredging there has been expended \$102.43.

Some minor repairs were also made to new breakwater. A few broken and rotted plank on portion of shore-arm built in 1879 were removed and replaced with new material.

One plate of boiler-iron 24 by 72 by $\frac{1}{4}$ inch was spiked on the angle between shore-arm and lake-arm at ordinary water level, to protect the cribs from action of ice. The stairway leading from bank to end of the shore-arm was also repaired.

MATERIALS EXPENDED REPAIRING NEW BREAKWATER DURING FISCAL YEAR ENDING JUNE 30, 1883.

Pine timber	feet, B. M..	149
Pine plank (new)	do...	1,494
Pine plank (old)	do...	1,056
Screw and washer bolts (new)	pounds..	484
Iron (new)	do...	143
Spike (new)	do...	15
Spike (old)	do...	164
Nails (old)	do...	30

The sum of \$57.53 was expended for the above repairs.

THE NEW BREAKWATER.

During the fiscal year the work of prolonging the lake-arm of the breakwater has been carried on with varying energy and vigor under three different contracts.

(1.) *Under contract of August, 1880, with J. C. Williams, of Cleveland, Ohio.*—Operations were in progress at the beginning of the fiscal year, and were continued until December 6, 1882, when it was substantially completed and contract closed. In this time the contractor sunk five cribs in water of about 30 feet in depth, making 250 linear feet of crib-work, filled the same with stone, and protected them with riprap; built 600 linear feet of superstructure, filled the same with stone and decked it over, and completed the unfinished superstructure of the last fiscal year.

Under the contract of J. C. Williams, 1,006 feet linear of breakwater was constructed; this portion of the breakwater was built in water gradually increasing in depth from 27 to 30 feet, width of 32 feet, and height of superstructure above the ordinary level of the lake is 8 feet. The average cost of this 1,006 feet linear, including contingencies, was \$108.50 per linear foot.

For a full exhibit of materials used see Exhibit B, transmitted herewith.

The time for completing the contract had to be twice extended by the Chief of Engineers. The unfinished counter-hewing on north face was satisfactorily completed in June, 1883. The work under this contract progressed in an unsatisfactory way and was not pushed with proper vigor; this was principally due to the fact that Mr. J. C. Williams, after executing the contract, was called away to assume charge of certain railroad construction, for which he had accepted the position of chief engineer.

(2.) *Under contract of June 20, 1881, with Sherwood, Striebinger & Geissendorfer, of Cleveland, Ohio.*—(Extended as to time of completion to Sep-

During the fiscal year the contractors have built 300 linear feet of foundation, requiring about 548 cords of stone; have sunk eighteen cribs in water of about 30 feet in depth, making 900 linear feet of cribs in place; filled the same with stone, requiring about 4,392 cords of stone, and protected eleven of the eighteen cribs with riprap, requiring about 4,219 tons of stone. They have built 750 feet linear of completed superstructure and made proper bonds with superstructure built under Mr. Williams' contract, and partially built and bonded 50 linear feet additional of superstructure.

During the fiscal year the contractors have expended the following amount of materials:

Hemlock timber.....	feet B. M.	1,730, 214
Pine timber	do	569, 303
Oak	do	41, 503
Treenails	do	2, 081
Screw and washer bolts	pounds	14, 992
Drift-bolts	do	188, 845
Spike	do	9, 978
Foundation stone	cords	549
Riprap stone	tons	4, 219
Filling stone	cords	5, 724

The work so far has not been pushed with the vigor that it might have been, and some delay has occurred for want of timber and from unfavorable weather.

During the present season it is expected that the balance of work required to construct 1,500 feet linear of finished breakwater will be completed as per terms of the contract.

3. *Under contract of October 4, 1882, with L. P. and J. A. Smith, of Cleveland, Ohio.*—Operations were begun in November, 1882, with construction of foundation, and at the close of the fiscal year were in full progress.

During this time the contractors have built 650 linear feet of foundation, requiring about 1,662 cords of stone; have sunk nine cribs in water of about 30 feet in depth, making 450 feet linear of cribs in place; filled the same with stone, requiring 1,281 cords of filling stone, and protected four of the nine cribs with riprap, requiring 1,781 tons of stone. They have expended the following materials:

Hemlock timber.....	feet B. M.	941, 922
Pine timber	do	68, 686
Screw and washer bolts	pounds	8, 983
Drift-bolts	do	80, 966
Spike	do	1, 112
Foundation stone	cords	1, 662
Filling stone	do	2, 300
Riprap stone	tons	1, 781

The work so far has been pushed with considerable energy and good progress made, and if the same rate of progress is continued all of the remaining fourteen cribs (required under this contract) will be sunk in place, and the greater part of the superstructure built thereon. As the result of the work during the fiscal year we have 950 linear feet of foundation built, 1,600 linear feet of crib-work has been sunk in water of about 30 feet in depth, 1,350 linear feet of superstructure has been completed and 50 feet partially so. During the present season it is proposed to build 500 feet of foundation, to sink 950 linear feet of crib-work, and complete 1,850 linear feet of superstructure, which, if all is accomplished, will complete the lake-arm of breakwater.

amount appropriated to date has been \$800,000, of which sum \$560,160.91 had been expended up to June 30, 1883, less about \$19,000 expended in repairs to piers and dredging at mouth of the Cuyahoga River, and the balance of \$263,839.09 is pledged under existing contracts. The balance available July 1, 1882, although apparently large, will be almost all expended by November, 1883.

The sum of \$400,000 can be profitably expended during the period ending June 30, 1885, in prolonging the east pier at the mouth of the Cuyahoga River, or otherwise completing the harbor of refuge.

This whole amount should be allotted in one appropriation act, so that the work can be economically pushed to an early completion, and the full benefit given to the growing commerce of the great lakes.

Cleveland Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the third order on shore, and a beacon on the outer end of each pier. The nearest work of defense is Fort Wayne, Mich., 110 miles distant.

The amount of revenue collected during eleven months ending May 31, 1883, was \$226,099.08.

The value of the imports was \$54,480,006, and of the exports \$36,449,853, during the year ending December 31, 1882.

Four thousand three hundred and seventy-four vessels, with an aggregate tonnage of 1,927,863 tons, entered, and three thousand nine hundred and thirty-eight vessels, with an aggregate tonnage of 1,825,218 tons, cleared during the year ending December 31, 1882.

The largest cargo that entered was 2,470 gross tons of iron ore, the vessel drawing 15 feet.

Money statement.

July 1, 1882, amount available	\$213,271 70
Amount appropriated by act passed August 2, 1882.....	175,000 00
	<hr/> 388,271 70
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	\$128,661 18
July 1, 1883, outstanding liabilities.....	8,876 18
	<hr/> 137,537 36
July 1, 1883, amount available.....	250,734 34
	<hr/> 400,000 00
Amount (estimated) required for completion of existing project.....	400,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	400,000 00

Abstract of proposals for iron for constructing 1,150 linear feet, more or less, of the new breakwater at Cleveland, Ohio, received and opened by Maj. John M. Wilson, Corps of Engineers, at United States Engineer office, Cleveland, Ohio, at 11 o'clock a. m., Thursday, September 21, 1882, under advertisement of August 21, 1882.

Materials.	1. Andrew Lacour, Cleveland, Ohio.	2. William H. McCurdy, Cleveland, Ohio.*	3. Frank Wilson, Cleveland, Ohio.	4. William P. Stanton, Cleveland, Ohio.	5. James Barnett, Cleveland, Ohio.
Bolts, screw and washer, 966 (16,400 pounds), more or less:					
Per pound.....	\$0 08½	\$0 03.85	\$0 03.84	\$0 08.55	\$0 04
Total.....	590 40	631 40	629 76	582 20	656 00
Drift-bolts, 28,700 (224,000 pounds), more or less:					
Per pound.....	02.73	02.7	02.74	03.15	02.7
Total.....	6,115 20	6,048 00	6,137 60	7,056 00	6,048 00
Boat spiko, 13,000 pounds, more or less:					
Per pound.....	03.85	03.25	03.57	08.55	03½
Total.....	435 50	422 50	464 10	461 50	455 00
Total amount of bid.....	7,141 10	7,101 90	7,231 46	8,099 70	7,159 00

* Contract awarded subject to approval of the Chief of Engineers.

Materials.	1. Sims & Sherwood, Cleveland, Ohio.	2. C. F. Dennis, Buffalo, N. Y.	3. Jacob Striebing, Cleveland, Ohio.	4. L. P. & J. A. Smith, Cleveland, Ohio.*	5. Charles H. Strong, Cleveland, Ohio.
Hemlock timber and plank, 1,914,750 feet B. M., more or less:					
Per 1,000 feet, B. M.	\$24 00	\$23 00	\$24 00	\$22 50	24 15
Total	45,954 00	44,030 25	45,954 00	43,081 87	44,241 27
White-pine timber and plank, 737,340 feet, B. M., more or less:					
Per 1,000 feet, B. M.	34 00	30 00	31 00	28 00	29 85
Total	25,069 56	22,120 20	22,857 54	20,645 52	22,000 00
White-oak timber and plank, 61,700 feet, B. M., more or less:					
59,225 feet, B. M., per 1,000 feet	41 00	40 00	40 00	35 00	30 00
†2,475 feet, B. M., per 1,000 feet	75 00	2,468 00	2,468 00	2,150 50	1,851 00
Total	2,613 85				
Treenails, 1,686, more or less:					
Per 100	6 00	5 00	5 00	4 00	5 00
Total	101 16	84 30	84 30	67 44	84 30
Stone for foundation, 2,400 cords, more or less:					
Per cord	6 90	7 00	6 25	5 90	6 15
Total	16,560 00	16,800 00	15,000 00	14,160 00	14,780 00
Stone for filling, 7,800 cords, more or less:					
Per cord	6 90	7 00	6 25	6 00	6 15
Total	50,370 00	51,100 00	45,625 00	43,800 00	44,285 00
Stone for riprap, 8,000 tons, more or less:					
Per ton	2 00	1 80	1 70	1 60	1 80
Total	16,000 00	14,400 00	13,600 00	12,800 00	14,400 00
Total amount of bid	156,668 57	151,011 75	145,588 84	136,714 33	144,241 11

* Contract awarded subject to approval by the Chief of Engineers.

† Stubbing-posts \$75 per 1,000 feet, B. M.

Abstract of proposals for furnishing 3,000 drift-bolts 1½ by 23 inches, 7,600 pounds boat spike 9 by 7½ inches, and 200 pounds boat spike 12 by ½ inches, more or less, for the new breakwater at Cleveland, Ohio, received and opened by Capt. L. Cooper Overman, Corps of Engineers, at the United States Engineer office, Cleveland, Ohio, at 11 o'clock a. m., Wednesday, January 3, 1883, under advertisement of December 4, 1882.

Materials.	1. James Barnett, Cleveland, Ohio.		2. Frank Wilson, Cleveland, Ohio.		3. William H. McCurdy, Cleveland, Ohio.		4. William P. Stanton, Cleveland, Ohio.*	
	Per pound.	Total.	Per pound.	Total.	Per pound.	Total.	Per pound.	Total.
Drift-bolts, 3,000 (18,000 pounds), more or less.....	\$0 02½	\$465 00	\$0 02½	\$465 00	\$0 02½	\$465 00	\$0 02½	\$463 00
Boat spike, 7,600 pounds, more or less.....	0 03½	265 20	0 03½	258 50	0 03½	245 70	0 02½	220 20
Total		730 20		718 50		710 70		700 00

* Contract awarded subject to approval of the Chief of Engineers.

Abs tract of contracts for improving harbor at Cleveland, Ohio, in force during fiscal year ending June 30, 1883.

Materials.	Names and addresses of contractors and date of contract.				
	John C. Williams, Cleveland, Ohio (Aug. 28, 1880).*	Sherwood, Striebling & Geissendorfer, Cleveland, Ohio (June 20, 1881).	L. P. & J. A. Smith, Cleveland, Ohio (Oct. 4, 1882).	William H. McCurdy, Cleveland, Ohio (Oct. 6, 1882).†	William P. Stanton Cleveland, Ohio (Jan. 11, 1883).‡
White-pine timber and plank, B. M. per M feet..	\$23 75	\$23 00	\$28 00	.....	.....
Hemlock timber and plank, B. M. do	19 50	23 00	22 50	.....	.....
White-oak timber and plank, B. M. do	27 25	40 00	35 00	.....	.....
Treenails per 100	4 50	5 00	4 00	.....	.....
Stone for foundation per cord	4 50	5 95	5 90	.....	.....
Stone for filling do	4 50	5 95	6 00	.....	.....
Stone for riprap per ton of 2,240 pounds..	1 55	1 60	1 60	.....	.....
Screw and washer bolts per pound .....	.....	.....	.....	\$0 3. 85	.....
Drift-bolts do .....	.....	.....	.....	0 2. 7	\$0 2. 6
Boat spike (with large heads) do .....	.....	.....	.....	0 3. 25	0 2. 90

* Contract substantially completed and closed December 6, 1882; final payment made March 19, 1883.

† Contract completed and closed January 15, 1883.

‡ Contract completed and closed February 8, 1883.

Abstract of materials used in the construction of 1,006 linear feet of breakwater at Cleveland, Ohio, by John C. Williams, under his contract of August 28,

Where used.	Foundation stone.	Filling stone.	Riprap stone.	Hemlock.		Pine.		Oak timber and plank.	Tree-nails.		Screw and washer bolts.		Drift-bolts.				Spil.		
				Timber.	Plank.	Feet, B. M.	Feet, B. M.		Feet, B. M.	Feet, B. M.	No.	Lbs.	No.	Lbs.	No.	Lbs.		No.	Lbs.
	Cords.	Cords.	Tons.																
Foundation.	2, 43g. 84		6, 322. 29																
Riprap to cribs.																			
Crib No. 1, sunk July 2, 1881.	223. 12			76, 296	342	2, 568			88	42	672			658		188		1, 164	
Crib No. 2, sunk July 9, 1881.	223. 12			76, 296	342	2, 568			88	42	672			658		188		1, 164	
Crib No. 3, sunk July 25, 1881.	223. 12			76, 296	342	2, 568			88	42	672			658		188		1, 164	
Crib No. 4, sunk August 5, 1881.	223. 12			76, 296	342	2, 568			88	42	672			658		188		1, 164	
Crib No. 5, sunk August 9, 1881.	223. 12			76, 296	342	2, 568			88	42	672			658		188		1, 164	
Crib No. 6, sunk August 18, 1881.	223. 12			76, 296	342	2, 568			88	42	672			658		188		1, 164	
Crib No. 7, sunk August 29, 1881.	223. 12			76, 296	342	2, 568			88	42	672			658		188		1, 164	
Crib No. 8, sunk November 8, 1881.	223. 12			76, 296	342	2, 568			88	42	672			658		188		1, 164	
Crib No. 9, sunk April 14, 1882.	223. 12			76, 296	342	2, 568			88	42	672			658		188		1, 164	
Crib No. 10, sunk April 18, 1882.	223. 12			76, 296	342	2, 568			88	42	672			658		188		1, 164	
Crib No. 11, sunk May 3, 1882.	223. 12			76, 296	342	2, 568			88	42	672			658		188		1, 164	
Crib No. 12, sunk May 19, 1882.	243. 96			78, 864	342	6, 612			96	42	672			726		196		1, 213	
Crib No. 13, sunk May 24, 1882.	243. 96			78, 864	342	6, 612			96	42	672			726		196		1, 213	
Crib No. 14, sunk June 6, 1882.	243. 96			78, 864	342	6, 612			96	42	672			726		196		1, 213	
Crib No. 15, sunk June 21, 1882.	243. 54			76, 296	342	6, 612			92	42	672			692		192		1, 189	
Crib No. 16, sunk October 15, 1882.	237. 90			82, 908	342	6, 612			100	42	685			760		200		1, 238	
Crib No. 17, sunk August 24, 1882.	243. 96			78, 864	342	6, 612			96	42	685			726		196		1, 212	
Crib No. 18, sunk September 13, 1882.	243. 96			78, 864	342	6, 612			96	42	685			726		196		1, 214	
Crib No. 19, sunk September 23, 1882.	243. 96			82, 908	342	2, 568			96	42	685			726		196		1, 215	
Crib No. 20, sunk October 3, 1882.	254. 38			82, 908	342	6, 612			100	42	683			760		200		1, 239	
Superstructure, including leveling, viz: built by Sherwood & Gelsander.							4, 843	249											

Number of crib in the pier:														
Crib No. 41	85.90	24,415	4,418	2,295/ 2"					254	2,085	57	352	79	471
Crib No. 42	85.84	26,923	4,418	2,578					284	2,330	65	400	98	454
Crib No. 43	91.07	30,461	4,592	2,578					314	2,515	113	700	86	478
Crib No. 44	91.18	27,365	4,592	2,578					300	2,445	83	508	90	460
Crib No. 45	90.80	27,339	4,544	2,578					318	2,474	80	490	82	465
Crib No. 46	91.80	28,044	4,608	2,578					304	2,522	80	490	86	476
Crib No. 47	96.20	27,484	4,672	2,578					310	2,490	74	454	84	485
Crib No. 48	97.22	30,505	7,470	3,981/ 4"					331	2,673	108	661	140	760
Crib No. 49	86.71	28,955	4,628	2,578	8				277	2,273	85	350	80	492
Crib No. 50	92.26	28,955	4,760	2,578	8	42	563		226	1,857	114	715	80	513
Crib No. 51	89.05	29,259	4,658	2,578		22	295		310	2,543	88	523	80	470
Crib No. 52	84.16	25,287	4,704	2,578					282	2,914	88	368	80	464
Crib No. 53			4,704	2,578					282	2,914	88	368	80	464
Crib No. 54	83.08	24,714	4,288	2,524/ 8"					273	2,241	63	399	77	466
Part of superstructure of crib														
Crib No. 76		6,961	300	176/ 5"					98	811	9	59	4	39
Crib No. 72	82.63	24,364	4,656	2,578					275	2,257	56	351	80	460
Crib No. 73	82.85	24,126	4,464	2,578					287	2,354	50	319	80	456
Crib No. 53	97.74	27,989	4,737	2,578		22	295		306	2,510	82	507	80	476
Crib No. 51	90.82	27,615	4,956	2,578	8	42	563		244	2,004	113	692	80	486
Crib No. 54	88.46	27,171	4,336	2,578		22	295		290	2,298	90	557	80	491
Part of superstructure of crib														
Crib No. 57			171						68	565	16	99	.....	11
Part of superstructure of crib														
Crib No. 71	78.50	18,650	4,512	2,408/ 4"					194	1,595	44	272	77	467
Crib No. 74	79.94	24,119	4,818	2,613/ 8"					293	2,401	38	235	80	488
Total.....														
2,436.84										19,692	160,896	5,373	83,257	1,690.11,297

IMPROVEMENT OF FAIRPORT HARBOR, OHIO.

Grand River rises in the northeastern part of Ohio and after a very circuitous course empties into Lake Erie at a point about midway between its eastern and western extremities.

A full description of the operations carried on for the improvement of this harbor during the past fifty-five years will be found in Annual Reports for 1880 and 1881.

The project of improvement adopted in 1825, when the mouth of the river was closed by a sand-bar so hard and dry in summer that teams could drive across, and which project has been amended from time to time since that date, as the demands of commerce called for an increased depth of water, provides for parallel piers 200 feet apart, running out from each side of the entrance to a depth of 16 feet in the lake.

OPERATIONS DURING THE FISCAL YEAR.

At the beginning of the fiscal year there was only a balance on hand of \$5,368.01; too small to begin the extensive work required.

By act of August 2, 1882, the sum of \$10,000 was appropriated for this harbor.

A contract was executed October 6, 1882, with C. T. Dennis, of Buffalo, N. Y., for the extension of the west pier 160 feet, more or less, and repair of 80 feet, more or less, of superstructure of the west pier, which had settled.

Work under this contract was begun April 10, 1883, as required, and was in progress at the close of the fiscal year. The contractor has completed the construction of the four cribs required for the extension, and had commenced the excavation for foundation. The progress made was very poor and very unsatisfactory, and an extension of the time for completion will doubtless be asked for. A contract for iron for said extension and repairs was executed October 9, 1882, with James Barnett, of Cleveland, Ohio, and completed and closed April 5, 1883.

Amount expended during the fiscal year has been \$1,772.24, of which amount \$880.73 was expended for iron under contract of October 9, 1882.

During the season it is proposed to complete the contract of October 6, 1882, and make some necessary repairs to the east pier.

At the end of the fiscal year there was a good channel 200 feet wide, with a least depth of 16 feet at low water, from the lake up into the river.

The present project provides for the extension of both piers, for repairs, and for dredging, so as to obtain and maintain a good channel 16 feet deep from lake to docks near mouth of river. The estimated cost is \$93,000, of which sum \$33,000 has been appropriated.

This harbor is now the lake terminus of the Painesville and Youngstown Railroad.

The trade in coal and iron is increasing.

Thirty thousand dollars can be expended during the period ending June 30, 1885, in furtherance of the revised project of 1882.

Up to the present time the sum of \$227,670.49 has been appropriated, of which sum \$214,074.72 has been expended.

Fairport Harbor is in the collection district of Cuyahoga, Ohio.

There is a fixed white light of the third order on shore, and a beacon on the east pier.

The amount of revenue collected during eleven months ending May 31, 1883, was \$72.85.

The value of the imports was \$400,411, and of the exports \$1,800, during the year ending December 31, 1892.

Seventy-one vessels, with an aggregate tonnage of 55,546 tons, entered, and sixty-one vessels, with an aggregate tonnage of 30,503 tons, cleared during the year ending December 31, 1892.

The largest cargo that entered was 1,500 gross tons of iron ore, the vessel drawing 14 feet 10 inches.

Money statement.

July 1, 1882, amount available.....	\$5,368 01
Amount appropriated by act passed August 2, 1882	10,000 00
	15 368 01
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	1,772 24
July 1, 1883, amount available.....	13,595 77
Amount (estimated) required for completion of existing project.....	60,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	30,000 00

Abstract of proposals for iron for constructing 160 linear feet, more or less, of the west pier, and leveling up the superstructure upon 80 linear feet, more or less, of pier at Fairport Harbor, Ohio, received and opened by Maj. John M. Wilson, Corps of Engineers, at United States Engineer office, Cleveland, Ohio, at 11 o'clock a. m., Thursday, September 21, 1882, under advertisement of August 21, 1882.

Materials.	1. James Barnett, Cleveland, Ohio.*		2. William P. Stanton Cleveland, Ohio.		3. Frank Wilson, Cleveland, Ohio.		4. Andrew Lacour, Cleveland, Ohio.	
	Per lb.	Total.	Per lb.	Total.	Per lb.	Total.	Per lb.	Total.
Bolts, screw and washer, 128 (2,200 pounds), more or less	\$0 04	\$88 00	\$0 03.62	\$79 86	\$0 03.99	\$87 78	\$0 03.85	\$84 70
Drift-bolts, 3,500 (27,000 pounds), more or less	02.85	769 50	03.28	872 10	02.89	780 30	02.98	804 60
Boat spike, 1,200 pounds, more or less	03 75	45 00	03.62	43 56	03.74	44 88	03.80	43 20
Total		902 50		995 52		912 96		932 50

* Contract awarded subject to approval of the Chief of Engineers.

1916 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of proposals for constructing 160 linear feet, more or less, of the west pier, and leveling up the superstructure upon 80 linear feet, more or less, of pier at Fairport Harbor, Ohio, received and opened by Maj. John M. Wilson, Corps of Engineers, at United States Engineer office, Cleveland, Ohio, at 11 o'clock a. m., Thursday, September 21, 1882, under advertisement of August 21, 1882.

Materials.	1. C. Schutz, Cleveland, Ohio.	2. Alonzo F. McKenzie, Ashtabula, Ohio.	3. C. T. Dennis, Buffalo, N. Y.*
Hemlock timber, 155,904 feet, B. M., more or less:			
Per 1,000 feet, B. M.	\$24 00	\$26 00	\$23 00
Total	3,741 70	4,053 50	3,585 70
White-pine timber and plank, 108,743 feet, B. M., more or less:			
Per 1,000 feet, B. M.	36 00	36 50	36 00
Total	3,914 75	3,969 12	3,283 23
Oak timber, 5,420 feet, B. M., more or less:			
Per 1,000 feet, B. M.	40 00	48 00	40 00
Total	216 80	260 16	216 80
Treenails, 272, more or less:			
Per 100	5 00	6 00	5 00
Total	13 60	16 32	13 00
Stone for filling and foundation, 700 cords, more or less:			
Per cord	9 50	8 00	8 00
Total	6,650 00	5,600 00	5,600 00
Dredging 1,000 cubic yards, more or less:			
Per cubic yard	90	63	50
Total	900 00	630 00	500 00
Total amount of bid	15,436 85	14,529 10	12,178 46

* Contract awarded subject to approval of the Chief of Engineers.

Abstract of contracts for improving harbor at Fairport, Ohio, in force during fiscal year ending June 30, 1883.

Materials.	Names and addresses of contractors and date of contracts.		
	Edwin H. French, Fulton, N. Y. (April 10, 1882).*	C. T. Dennis, Buffalo, N. Y. (Oct. 6, 1882).	James Barnett, Cleveland, Ohio (Oct. 9, 1882).
Hemlock timber, per 1,000 feet, B. M.		\$23 00	
White-pine timber and plank, per 1,000 feet, B. M.		30 00	
Oak timber, per 1,000 feet, B. M.		40 00	
Tree nails, per hundred		5 00	
Stone for filling and foundation, per cord of 128 cubic feet		8 00	
Screw and washer bolts, per pound			\$9 04
Drift bolts, per pound			2 85
Boat spike (with large heads), per pound			60
Sand, &c., per cubic yard in scows	\$0 27		
Sand, &c., per cubic yard in position		80	

* Contract completed and closed June 19, 1882, unintentionally omitted to be reported as closed during fiscal year ending June 30, 1882.

APPENDIX L L.

IMPROVEMENT OF THE HARBORS ON LAKE ERIE AT ASHTABULA AND CONNEAUT, OHIO; ERIE, PENNSYLVANIA; AND DUNKIRK, NEW YORK.

REPORT OF CAPTAIN MILTON B. ADAMS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|----------------------------|-------------------------------|
| 1. Ashtabula Harbor, Ohio. | 3. Erie Harbor, Pennsylvania. |
| 2. Conneaut Harbor, Ohio. | 4. Dunkirk Harbor, New York. |

UNITED STATES ENGINEER OFFICE,
Erie, Pa., July 7, 1883.

GENERAL: I have the honor to transmit herewith my annual reports on the harbors under my charge for the fiscal year ending June 30, 1883.

I am, general, very respectfully, your obedient servant,
M. B. ADAMS,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

L L i.

IMPROVEMENT OF ASHTABULA HARBOR, OHIO.

The original project for the improvement of this harbor was adopted in 1826, at which time there was only a depth of 2 feet of water on the bar; this project has been modified from time to time in order to meet the demands of commerce and increased draught of vessels navigating the lakes; it provided piers running out into the lake to 12 feet in depth, whereas the present design is to carry them out to 16 feet in depth. At shore the piers are 160 feet apart, but they approach each other going away from shore, and are only 100 feet apart 900 feet off shore, then the west one flares to the westward in the next 200 feet, and at 1,100 feet off shore the piers are 160 feet apart again, after which the west pier is prolonged parallel to the east pier. Before operations were commenced rock was encountered at 7 to 9 feet under the water surface, extending across the channel in the form of a wide reef, which has required blasting and dredging for its removal in order to secure the present depth of 16 feet.

this portion of the west face of the channel. The removal of this old and dilapidated pier cannot well be undertaken, however, until the 280 feet of the west pier now being constructed has been completed, securing the connection of the pier with the shore, and some kind of revetment 820 feet further shoreward has been effected; nor, indeed, until the removal of the rock reef along this front can all be accomplished; since, otherwise, vessels on entering the harbor would constantly be liable to encounter a dangerous obstruction in the form of a rock reef jutting out 50 to 70 feet into the channel, but which is now bordered by the old pier, and thus, even in its dilapidated condition, subserves this good purpose of fending vessels from the reef.

Both piers should be extended from time to time if this should be found necessary in order to keep their outer ends resting at the 16-foot curve in the lake; 500 feet of the east pier should be renewed, and 400 feet of the same pier should receive a new superstructure—being the 900 feet adjacent to the shore.

The estimated cost of the foregoing is as follows:

Constructing 800 linear feet of revetment, west side, at \$15 per foot	\$12,000
Removing 1,100 feet of the old west pier, at \$5 per foot	5,500
Dredging 20,000 cubic yards of sand, west side, at 25 cents per yard	5,000
Blasting and dredging 11,000 cubic yards of rock, west side, at \$2 per yard ..	22,000
Removing 500 feet of old east pier, at \$5 per foot	2,500
Rebuilding 500 feet of east pier, at \$30 per foot	15,000
Rebuilding 400 feet of superstructure, east pier, at \$10 per foot	4,000
Prolonging the east pier 250 feet, at \$70 per foot	17,500
Contingencies	8,300
Total	91,800

The entire amount, \$91,800, can be profitably expended during the fiscal year ending June 30, 1885, for the objects as stated.

OPERATIONS DURING THE FISCAL YEAR.

The amount of funds available for this harbor, after deducting the cost of constructing 280 feet of the west pier, under contract and now in progress, is only about \$8,000, a sum too small with which to undertake any of the before-enumerated pieces of work, which could be properly separated, unless it would be the repairing of 400 feet of the east pier; but this not being as important as some of the others, besides the possibility of dredging being required at any time during the season of navigation, has prevented any other work than that under contract from being commenced. The construction of 280 feet of new pier, under contract dated October 5, 1882, was commenced April 2, 1883, and has been progressing satisfactorily; the seven cribs required in the work are completed, and the foundation has been prepared, about ready to receive them. The iron for the work has all been furnished in accordance with the contract for iron and the contract closed. Soundings at the mouth of the harbor were made April 10, 1883, and showed there was a bar of limited area (50 by 100 feet) formed 300 feet outside the piers, probably due to some submerged drift brought there during the unusual freshets in the early spring, on which there was a least depth of 13.5 feet; there was a depth of 16 to 17 feet of water on all sides of this bar, however, and dredging operations were not, therefore, at once undertaken for its removal; consequently the authorities of the Pennsylvania Railroad

their part. During the present season it is proposed to complete the 280 feet of new west pier and to make some slight repairs to the decking of the piers, placing them in fair condition to resist the winter gales.

The total amount appropriated for this harbor up to the present time is \$349,901.21, of which sum \$328,731.78 have been expended. Attached to this report is a detailed statement of expenditures.

The commerce of Ashtabula and the importance of the harbor are rapidly increasing; both the Lake Shore and Pennsylvania Railroad companies continue to make extensive improvements and enlargements to their wharves at the harbor to accommodate their increased lake trade in coal, iron, lumber, &c.

Ashtabula Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the fifth order, raised by flashes, on the west pier. Fort Porter, N. Y., 120 miles distant, is the nearest work of defense.

The amount of revenue collected during the year ending December 31, 1882, was \$6,532; the value of imports was \$5,944,349; the value of exports was \$660,350. There were five hundred and ninety-eight vessels, aggregate tonnage 435,491 tons, entered, and six hundred and seven vessels, aggregate tonnage 440,372 tons, cleared, during the year.

Money statement.

July 1, 1882, amount available	\$3,161 43
Amount appropriated by act passed August 2, 1882.....	20,000 00
	<hr/>
	23,161 43
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	1,992 00
	<hr/>
July 1, 1883, amount available.....	21,169 43
	<hr/>
Amount (estimated) required for completion of existing project.....	91,800 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	91,800 00

Abstract of contracts for improving Ashtabula Harbor, Ohio, in force during the fiscal year ending June 30, 1883.

Materials.	Names and addresses of contractors and date of contract.	
	A. F. McKenzie, Ashtabula, Ohio (October 5, 1882).	James Barnett, Cleveland, Ohio (October 5, 1882).
White-pine timber and plank per 1,000 feet, B. M	\$32 50	.....
Hemlock timber per 1,000 feet, B. M	22 50	.....
Oak timber per 1,000 feet, B. M	38 00	.....
Treenails, per 100	6 00	.....
Screw and washer bolts, per pound		\$0 04.00
Drift-bolts, per pound		02.85
Boat spike, per pound		03.75
Stone furnished, per cord	7 50	.....
United States stone handled, per cord	2 50	.....
Old west pier removed, per foot	11 00	.....
Dredging, per cubic yard	72	.....

Date.	Amount.	Act approved—	Commercial statistics.			Draught.	How expended.
			Customs receipts.	Entered and cleared.	Tonnage.		
1826	\$12,000 00	May 20, 1826	.....	.....	.....	Feet 2-3	Pier construction continued in 1827.
1828	2,403 50	May 19, 1828	.....	.....	.....	4	Pier construction.
1829	6,940 25	Mar. 3, 1829	.....	.....	.....	4	Pier extension and dredging continued in 1831.
1831	7,015 00	Mar. 2, 1831	.....	.....	.....	4	Pier extension and dredging.
1832	3,800 00	July 3, 1832	.....	.....	.....	6½	Rock excavation.
1833	3,400 00	Mar. 2, 1833	.....	.....	.....	7	Do.
1834	5,000 00	June 28, 1834	.....	.....	.....	9	Rock excavation and dredging.
1835	7,591 00	Mar. 3, 1835	.....	.....	.....	9	Rock excavation and pier extension continued in 1836.
1837	8,000 00	Mar. 3, 1837	.....	.....	.....	9	Rock excavation, pier extension, and repairs.
1838	8,000 00	April 3, 1838	.....	.....	.....	8	Rock excavation, pier extension, and repairs. Work suspended until 1844.
1844	5,000 00	June 11, 1844	.....	.....	.....		Pier repairs. In 1845 some repairs of piers were made and fence constructed. Work was then suspended until 1852.
1852	10,000 00	Aug. 30, 1852	.....	.....	.....		Examination made.
1853	42 64	Mar. 3, 1853	.....	.....	.....		Pier repairs. Work suspended until 1866.
1866	24,708 82	June 23, 1866	.....	.....	.....	7½	Survey and estimate for repairs made.
1867	54,000 00	Mar. 2, 1867	.....	151	12,238	7½	Pier repairs.
1868	.....	.....	\$94 33	.....	.....	8	Pier extension.
1869	.....	.....	.....	.....	.....	9	Dredging.
1870	.....	.....	224 00	114	13,506	10	Dredging and rock excavation.
1871	15,000 00	Mar. 3, 1871	100 49	85	8,788	12	Rock excavation.
1872	15,000 00	June 10, 1872	2 00	50	3,992	13	Rock excavation and dredging.
1873	16,000 00	Mar. 3, 1873	.....	67	6,128	14	Do.
1874	35,000 00	June 22, 1874	.....	271	57,817	9	Dredging.
1875	25,000 00	Mar. 3, 1875	.....	482	143,081	12	Pier extension and dredging.
1876	5,000 00	Aug. 14, 1876	561 60	569	224,714	14	Dredging and rock excavation.
1877	.....	.....	404 35	583	312,295	13½	Pier repairs.
1878	12,000 00	June 18, 1878	749 05	628	358,693	14	Pier repairs and dredging.
1879	9,000 00	Mar. 3, 1879	811 60	588	386,368	13½	Pier extension and dredging.
1880	20,000 00	June 14, 1880	743 20	794	476,942	15	Pier extension and repairs.
1881	20,000 00	Mar. 3, 1881	6,474 34	1,037	845,707	15	Pier extension and dredging.
1882	20,000 00	Aug. 2, 1882	6,532 00	1,205	875,863	15	Do.

Total amount appropriated	\$349,901 21
Total amount expended	328,731 78
Total amount available	21,169 43
Amount under contract	12,316 18
Amount available for dredging and other incidental expenses	8,853 25

L L 2.

IMPROVEMENT OF CONNEAUT HARBOR, OHIO.

The project for the improvement of this harbor was adopted in 1829, and the bar at the mouth of Conneaut Creek was dry at low stages of water, when the original improvements were commenced. Operations were carried on during the years of 1829 to 1832, and from 1836 to 1838, inclusive, which comprised the construction of piers, 125 feet apart, running out from shore to a depth of 12 feet of water in the

through the bar and into Conneaut Creek—the harbor of Conneaut.

Works of improvement have progressed with more or less of interruptions and suspensions, no work having been done from 1832 to 1836; from 1839 to 1844; from 1845 to 1852; from 1852 to 1866, and none last year or this. The best channel depth ever obtained at the entrance was only 11 feet, the more usual depth being from 8 to 9 feet, and the commerce of the port has always been trifling; we may therefore say the hopes entertained for this harbor, when its improvement was undertaken, have never been realized.

It has been recommended that improvements should be made at this harbor as follows:

Renewing 800 feet of old east pier, at \$30 per foot.....	\$24,000
Rebuilding 790 feet of superstructure, west pier, at \$10 per foot.....	7,900
Contingencies 10 per cent	3,190
Total	35,090

I have nothing to add to this recommendation; indeed, it seems to me that unless the facilities for transportation by land to and from this harbor should be materially augmented, any outlay for the improvement of the harbor is injudicious; considerable sums have been expended during the last fifty years in preserving the harbor and its improvements without drawing private or incorporate enterprise in its direction; therefore the harbor must be regarded as of questionable advantage as a commercial outlet to and from the lake. Doubtless a good harbor could be made at Conneaut, *i. e.*, one affording water 16 feet deep, or deeper, with room enough inside, by dredging, for wharves, docks, &c., without involving a greater outlay than the improvement of other harbors along the lake has done; but such an admission only goes to show that at other harbors, with greater obstacles to overcome, the demand for a good harbor has produced one. I am informed that the construction of a railroad is contemplated, reaching from the coal fields, south and east of this harbor, to Conneaut, as an outlet; of course if this was done a great impetus would thereby be given to the commerce of the port, and this may justify further expenditures for the improvement of the harbor.

There have been no operations carried on at Conneaut Harbor during the fiscal year ending June 30, 1883, and none are contemplated this season, as there are no funds available.

During a strong northeast gale on the 21st of May last, about 120 feet of the old east pier were carried away, down to 6 feet below water level, leaving a gap 110 feet wide in the east pier, between a portion of the old pier farther out and the outer end of the new pile protection constructed in 1881, the pile work having overlapped the old pier some 10 feet before this; the estimate herewith submitted need not be increased on this account, however, for the old pier carried away is a portion of the same that is estimated at \$5 per foot for its removal.

The unusually high freshets of the early spring seem to have had a good effect by its scouring the channel out at this harbor, for soundings made there on the 13th of June showed a least depth into the harbor of 10 feet.

The total appropriations for this harbor, up to the close of the present fiscal year, is \$112,629.39, of which amount \$112,576.21 have been expended. At the end of this report is a detailed statement of expenditures.

The estimated cost of completing the existing project is \$35,090,

ceding estimate.

Conneant is in the collection district of Cuyahoga, Ohio; there is a fixed white light of the sixth order at the end of the west pier. Fort Porter, N. Y., 105 miles distant, is the nearest work of defense.

The amount of revenue collected during the year ending December 31, 1882, was \$56,20; the value of the imports was \$15,420, and the value of the exports was \$50. There were eighty-four vessels, with an aggregate tonnage of 1,065 tons, entered, and ninety vessels, with an aggregate tonnage of 1,755 tons, cleared, during the year.

Money statement.

July 1, 1882, amount available.....	\$231 23
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	178 05
July 1, 1883, amount available.....	53 18
Amount (estimated) required for completion of existing project.....	35,090 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	35,090 00

Statement in detail of annual appropriations, expenditures, customs collected, entrances, and of clearances, with their tonnage, for Conneant Harbor, Ohio.

Date.	Amount.	Act approved—	Commercial statistics.			Draught.	How expended.
			Customs receipts.	Entered and cleared.	Tonnage.		
1829	\$7,500 00	Mar. 2, 1829				<i>Fest.</i> 1-2	Survey, dam, and pier construction.
1830	6,135 65	Apr. 23, 1830				6	Pier extension.
1831	6,370 00	Mar. 2, 1831				8	Do.
1832	7,800 00	July 3, 1832				8	Pier extension; 1833 pier extension continued and dredging.
1836	2,500 00	July 2, 1836				9	Dredging.
1837	5,000 00	Mar. 3, 1837				10	Do.
1839	8,000 00	Apr. 3, 1839				11	Dredging and pier repairs.
1844	5,000 00	June 11, 1844				8	Examination, estimate, and pier repairs. 1845 pier repairs continued.
1852	10,000 00	Aug. 30, 1852					No work done this year. Pier repairs were made in 1853-54, and there was "10 feet" in 1855.
1866	20,513 74	June 23, 1866				8½	Examination and estimate.
1867	10,000 00	Mar. 2, 1867	\$33 25	44	3,836		Pier repairs.
1868			18 00				Do.
1869	8,910 00	Apr. 10, 1869					Pier extension.
1870	6,000 00	July 11, 1870	40 00	60	7,984		Pier repairs.
1871						9	Pier extension.
1872			54 20				Pier repairs.
1873	400 00	Mar. 3, 1873		14	1,118		Do.
1874	1,500 00	June 22, 1874		24	3,195		Do.
1875	1,000 00	Mar. 3, 1875			1,670	8	Do.
1876			12 25	28	1,669	8	
1877			57 40	24	1,297	8	
1878			51 75	12	1,571	8	
1879			55 25	14	1,614	8	Survey and estimate.
1880	6,000 00	June 14, 1880	32 25	10	1,838	10½	
1881			119 95	87	3,217	10	Pile revetment.
1882			56 20	174	2,810	7	Do.
Total amount appropriated							\$112,629 39
Total amount expended.....							112,576 21
Total amount available.....							53 18

The harbor of Erie is formed by the peninsula of Presque Isle, which almost entirely incloses an area of fine anchorage, with a sheltered outlet and offing to the eastward. The area inclosed, the bay of Presque Isle, measures some $4\frac{1}{2}$ miles in length by $1\frac{1}{2}$ miles in width, of which perfectly landlocked area about 2 miles by $1\frac{1}{4}$ miles affords water 18 feet or more in depth.

This fine harbor attracted the attention of the Government for its improvement and preservation as early as 1819, when a survey of the harbor was made; the original plan having the improvement of the harbor in view, was not adopted, however, until 1823, and the improvement as originally planned, with some minor modifications to adapt the channel to the increased draught of vessels, &c., constitutes the present entrance.

When operations were commenced, in 1823, the channel was narrow and tortuous, with a depth of only 6 feet. The plan of improvement then adopted consisted of two breakwaters running out—the one from the main shore, the other from the eastern end of the peninsula—in a direction nearly at right angles with the axis of the channel; and when the extremities of these breakwaters were, as originally planned, 200 feet apart, but now 350 feet apart, their direction was changed so that they were nearly parallel with the axis of the channel, and thereafter were prolonged as more substantial structures, being the piers on either side of the channel.

The present entrance to the harbor is 350 feet wide, and the design is now to extend the piers so as to cause their outer ends to be at the general line of the 16-foot curve in the lake, and to maintain a channel depth through the bars, inside and outside the piers, of not less than 16 feet.

Besides the operations necessary for the improvement and preservation of the eastern entrance to the harbor, a design was formed, after the breaching of the peninsula at its western end in 1832-'33, for an entrance there, and extensive operations were carried on during some years with that object in view; but nature seemed opposed to this design, considerable quantities of sand were carried into the bay while the opening (breach) continued, thus shoaling its western portion and somewhat contracting its area of anchorage. When work was suspended between 1857 and 1864, the breach (and artificial opening as far as completed) was closed from natural causes, and such a design at that part of the bay has not been since thought of. Indeed, most minds seem to be all too apprehensive now of danger to the harbor from a breach occurring at some part of the peninsula, and the Board of Engineers, which assembled at Erie June 14, 1882, with its report as published in the Annual Report of the Chief of Engineers for 1882, page 2420, has, I trust, made a satisfactory disposition of this matter; work in future will be directed to the closing of an actual breach when one occurs, in accordance with the decision of the Board. The channel at the east end of the bay—the entrance to the harbor—has been maintained 16 feet deep and 300 feet wide during the past year.

Under contract dated February 23, 1882, with J. Louis Linn, the work of rebuilding 385 feet of the north pier superstructure and redecking 90 feet progressed satisfactorily to completion on the 3d of August, 1882, when the contract was closed, and involved an expenditure subsequent to June 30, 1882, by Maj. John M. Wilson, Corps of Engineers, amounting to \$5,984.26.

Dredging from the channel of the outer and inner bars, under contract dated July 1, 1882, progressed satisfactorily to completion August 31, 1882, when 18,000 cubic yards of sand had been removed, as per contract, and the contract was closed. This involved an expenditure on the part of Maj. John M. Wilson, amounting to \$4,247.34, and on my part, being the cost of advertising the work, amounting to \$5.

The work of constructing a pile-protection at the neck of the peninsula, in progress when the Board of Engineers met here May 14, 1882, and which had received the approval of the Chief of Engineers, progressed satisfactorily, and was completed on the 5th of September, 1882, which involved an expenditure by Maj. John M. Wilson, Corps of Engineers, subsequent to June 30, 1882, amounting to \$2,424.03.

It was deemed necessary to add more riprap stone to the outer end of the north pier to secure it against further settlement, and under authority of the Chief of Engineers 37.48 cords of stone were purchased and placed there December 9, 1882, at a cost of \$5.50 per cord, amounting to \$206.14.

The construction of a catch-sand jetty at the east end of the peninsula, under contract dated October 5, 1882, commenced by April 10, 1883, and to date one hundred and ninety-three piles have been driven, completing the driving of piles on 249 feet of the jetty.

The miscellaneous expenses of the office, such as clerk hire, office rent, coal, stationery, &c., have amounted to \$1,856.04 during the year, \$556.82 by Maj. John M. Wilson, Corps of Engineers, and \$1,299.22 by myself.

PROPOSED OPERATIONS.

The amount required to complete the existing project, *i. e.*, to extend both piers to 16 feet depth of water in the lake, cannot well be definitely stated, owing to the continual accumulation of sand on the outer bar, which makes it highly probable that considerable extensions, some 1,000 feet to the north pier and 1,650 feet to the south pier, will be required to reach the 16-foot curve in the lake by the close of another season. The 16-foot curve has moved 200 feet away from the ends of the piers during the past year, and, indeed, unless the hopes entertained for the catch-sand jetty now being constructed are realized, and the sand should be prevented from accumulating as it now does, either large amounts of sand will require removal or else indefinite extensions of the piers must be made in order to maintain a depth of 16 feet through the outer bar. There are required at present 2,050 feet of pier extensions, 700 feet to the north pier and 1,350 feet to the south pier, in order to reach the place where the 16-foot curve crosses the channel, which, at a cost of \$65 per foot, will amount to \$133,250, the sum required to complete the existing project at the present time.

The Board of Engineers assembled here June 14, 1882, recommended \$10,000 of the amount available for Erie Harbor to be set apart to pro-

Pier construction and repairs, dredging, and dike construction, if needed, will comprise the operations of another season.

There could be profitably expended during the fiscal year ending June 30, 1885, \$133,250, in extending the piers and maintaining the present channel width and depth through the outer and inner bars.

The total amount appropriated for this harbor up to the close of the present fiscal year is \$681,367.23, and \$660,090.70 have been expended. Nearly one-third of this, however, was expended at the western end of the bay.

At the end of this report is a detailed statement of expenditures.

Erie Harbor is in the collection district of Erie, Pa. It is lighted with a coast light on the north shore of the peninsula, fourth order, flashing red and white; a fixed red, of the sixth order, on the outer end of the north pier; and two sixth-order fixed white lights marking the range of the channels within the bay. There is a fog-bell on the outer end of the north pier. Fort Porter, N. Y., 90 miles distant, is the nearest work of defense. The entire commerce of the lower lakes is more or less interested in the improvement of this harbor.

The amount of revenue collected during the year ending December 31, 1882, was \$18,243.08; the value of imports was \$1,525, and the value of exports was \$2,508. There were nine hundred and twenty-two vessels entered, with an aggregate tonnage of 777,957 tons, and nine hundred and nineteen vessels cleared, with an aggregate tonnage of 732,393 tons.

Money statement.

July 1, 1882, amount available.....	\$15,997 13
Amount appropriated by act passed August 2, 1882	20,000 00
	<hr/> 35,997 13
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882	14,720 60
	<hr/> 21,276 53
Amount (estimated) required for completion of existing project.....	133,250 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	133,250 00

Abstract of contracts in force during the fiscal year ending June 30, 1883.

Materials.	Names and addresses of contractors and date of contract.		
	J. Louis Lynn, Erie, Pa., * Feb- ruary 23, 1882.	J. Louis Lynn, Erie, Pa., * July 1, 1882.	Alonzo F. McKen- zie, Ashtabula, Ohio, October 5, 1882.
White-oak timber, per M feet B. M	\$30 00		\$49 00
White-pine timber, per M feet B. M	36 00		
Piles, per linear foot driven and cut off.....			31
Stone for filling, per cord of 128 cubic feet.....	10 00		
Screw and washer bolts, per pound.....			7½
Dredging sand, &c., per cubic yard, in scows		\$0 22½	
Ship and boat spikes, with large heads, per pound	4½		

* Contracts completed and closed August 3 and August 31, 1882, respectively.

Date.	Amount.	Act approved—	Commercial statistics.			Draught.	How expended.
			Customs receipts.	Entered and cleared.	Tonnage.		
1823	\$150 00	Mar. 3, 1823	-----	-----	-----	Feet. 6	Survey of entrance to the harbor.
1824	20,000 00	May 26, 1824	-----	-----	-----	6	Constructing dike or breakwater at entrance to harbor.
1825	-----	-----	-----	-----	-----	6	Constructing pier and breakwater at entrance to harbor.
1826	7,000 00	Mar. 25, 1826	-----	-----	-----	6	Constructing breakwater at entrance to harbor.
1827	2,000 00	Mar. 2, 1827	-----	-----	-----	6	Constructing pier at entrance to harbor.
1828	6,223 18	May 19, 1828	-----	-----	-----	7	Constructing dike and pier at entrance to harbor.
1829	7,390 25	Mar. 3, 1829	-----	-----	-----	7½	Closing breach in peninsula.
1830	-----	-----	-----	-----	-----	9	Repair of dike.
1831	1,700 00	Mar. 2, 1831	-----	-----	-----	-----	-----
1832	4,500 00	July 3, 1832	-----	-----	-----	-----	-----
1833	6,000 00	Mar. 2, 1833	-----	-----	-----	12	Prolonging dike.
1834	23,045 00	June 28, 1834	-----	-----	-----	12	Closing breach at junction of south pier and breakwater.
1835	5,000 00	Mar. 3, 1835	-----	-----	-----	13	Breakwater and pier.
1836	15,122 80	July 2, 1836	-----	-----	-----	-----	Repairing piers east end of bay, constructing breakwater west end.
1837	15,000 00	Mar. 3, 1837	-----	-----	-----	-----	\$22,349 56 has thus far been expended on west end of bay.
1838	30,000 00	Apr. 3, 1838	-----	-----	-----	-----	Pier work east end, crib work west end of bay.
1839	-----	-----	-----	-----	-----	-----	Pier work and snags removed east end, break water west end.
1843	-----	-----	-----	-----	-----	-----	Pier east end of bay.
1844	40,000 00	June 11, 1844	-----	-----	-----	-----	Pier east end, crib-work west end.
1845	-----	-----	-----	-----	-----	10	Pier and breakwater, and dredging at east end.
1846	-----	-----	-----	-----	-----	-----	Pier and breakwater east end.
1852	30,000 00	Aug. 3, 1852	-----	-----	-----	-----	Pier east end, shore revetted west end.
1853	-----	-----	-----	-----	-----	-----	Do.
1854	-----	-----	-----	-----	-----	-----	Closing breach and protecting peninsula west end.
1855	-----	-----	-----	-----	-----	-----	Do.
1856	-----	-----	-----	-----	-----	9	Repairs of piers and dredging east end, protecting peninsula west end.
1864	15,000 00	June 28, 1864	-----	-----	-----	13	-----
1865	-----	-----	-----	-----	-----	-----	-----
1866	36,961 00	June 23, 1866	-----	-----	-----	-----	-----
1867	25,000 00	Mar. 2, 1867	21,182 00	2,119	421,874	14	Piers and dredging east end.
1868	40,000 00	July 25, 1868	11,373 00	2,229	740,894	13	Do.
1869	22,275 00	Apr. 10, 1869	20,670 00	2,438	878,600	14	Do.
1870	20,000 00	July 11, 1870	41,271 66	2,306	899,892	14	Do.
1871	39,000 00	Mar. 3, 1871	-----	2,974	1,398,771	14	Do.
1872	15,000 00	June 10, 1872	32,806 84	2,392	1,277,704	-----	Dredging at east end, protecting peninsula west end.
1873	-----	-----	58,565 84	2,594	1,160,017	14	Piers and dredging east end.
1874	20,000 00	June 22, 1874	26,923 23	2,007	1,097,005	-----	Piers and dredging east end, and protecting peninsula west end.
1875	80,000 00	Mar. 3, 1875	36,967 62	1,255	734,384	-----	Do.
1876	40,000 00	Aug. 4, 1866	81,631 87	1,514	871,644	12	Do.

Commercial statistics.

Date.	Amount.	Act approved—	Commercial statistics.			Draught.	How expended.
			Customs receipts.	Entered and cleared.	Tonnage.		
1877	-----	-----	\$37,843 51	\$1,450	848,472	-----	Piers and dredging east end, protecting peninsula west end.
1878	\$25,000 00	June 18, 1878	17,085 46	1,747	1,324,745	-----	Do.
1879	25,000 00	Mar. 3, 1879	9,162 85	1,941	1,478,320	15	Dredging east end.
1880	25,000 00	June 14, 1880	4,910 19	2,024	1,565,183	16	Piers and dredging east end, and several snags removed.
1881	20,000 00	Mar. 3, 1881	25,756 00	1,813	1,441,000	16	Piers east end, protecting peninsula west end.
1882	20,000 00	Aug. 2, 1882	18,243 08	1,841	1,510,350	16	Piers and dredging east end, protecting peninsula west end.

Total amount appropriated	\$681,367 23
Total amount expended	660,090 70
Total amount available	21,276 53
Amount set apart and under contract for the protection of peninsula	18,231 58
Amount available for incidental expenses	8,044 95

NOTE.—Of the amount available, \$22,134.35, there were \$10,000 set apart for the protection of the peninsula, by the Board of Engineers, which met here June 13, 1882, and there is under contract for constructing a catch-and jetty this season \$8,231.58, leaving a balance of \$3,902.79, which will only meet the running expenses of the harbor this year, leaving nothing for dredging and repairs of piers.

L L 4.

IMPROVEMENT OF DUNKIRK HARBOR, NEW YORK.

The original improvement of this harbor was commenced in 1827, when the first appropriation was made. The original design was much the same as that of the existing improvement, which comprises the formation of an artificial harbor in front of the city by means of a breakwater running nearly parallel with the shore, and a shore-arm or pier to the westward, with an opening between the pier and the breakwater. By 1832 the sum of \$28,489.84 had been expended on the original plan, and the breakwater was then 2,564 feet long and the pier 1,400 feet long. Various improvements and repairs were made from time to time; by 1838 there had been completed, at a cost of \$88,446, 2,125 feet of breakwater and 300 feet of detached breakwater. These structures were doubtless rather ephemeral in character, as shown both by their cost and the fact that in 1848 the breakwater was demolished. Between 1848 and 1870 some portions of the work were renewed and others repaired, but in 1870 a Board of Engineers took into consideration the question of the radical improvement of this harbor. The Board recommended a plan which provided a breakwater 2,860 feet long, one part of which was to be nearly parallel with the shore, 2,300 feet in length; the other part to be nearly parallel to the axis of the channel entrance, 560 feet long, and terminating at the position of the dumb beacon. Of the 2,200-foot section there have been completed 1,341 feet; none of the 560-foot section has yet been built.

1928 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

In consideration of the exposed condition of the entrance from both wind and waves between points west, northwest, and around to northeast, the narrowness of the channel, and the jutting banks of submerged rock on either side of it, I would recommend, in future operations at this harbor, that the 560-foot section should be constructed in order to ameliorate the condition of this somewhat dangerous entrance.

The benefits to this harbor, or, more properly, to the commerce of the harbor, have never been fully realized. The class of vessels engaged in the lake commerce is much larger, with increased draught, since the improvement of this harbor was last planned, and while the accommodations it offered no doubt sufficed for such vessels as were on the lakes a few years ago, they are inadequate to the wants of the larger class of vessels of the present day; besides, unfortunately for its improvement, it cannot be made to accommodate the larger vessels except at an enormous expense, since any depth more than 12.5 feet throughout the entire inclosed area of the harbor must be gained by excavating its solid rock bed. Indeed, I may add that persons who were most sanguine for the lake commerce of Dunkirk a few years ago are now compelled to very much modify, if not abandon, their expectations. The contract dated September 22, 1880, for the extension of the breakwater 150 feet, with George W. White, was completed and closed August 7, 1883, and involved an expenditure by Maj. Walter McFarland, Corps of Engineers, amounting to \$3,580.08. Since the harbor was turned over to my charge there has occurred an expenditure amounting to \$31.73, incidental to the transfer, being for express and freight charges on property shipped to me at Erie, Pa., and for traveling expenses.

There being no money available, no work is contemplated this year.

The breakwater might, with benefit to the harbor, be extended 560 feet to the westward and 300 feet to the eastward, a total of 860 feet; and would then be 659 feet shorter than its originally estimated length. The cost of such extension, at \$70 per linear foot, would amount to \$60,900, which entire amount could be profitably expended in the fiscal year ending June 30, 1885.

The total appropriated for this harbor has amounted to \$449,079.38, of which sum \$449,025.29 have been expended. There is at the end of this report a statement in detail of the expenditures.

Dunkirk Harbor, New York, is in the collection district of Dunkirk. It is lighted by a third-order lake-coast light, fixed white, varied by white flashes, and a sixth-order fixed white beacon light, west side of the channel entrance. The dumb beacon which was on the east side of the entrance has been carried away.

Fort Porter, 40 miles to the eastward, is the nearest work of defense.

The amount of revenue collected during the year ending December 3, 1882, was \$48 46; the value of the imports was \$710.95; there were no exports. The number of entrances and clearances is not known.

Money statement.

July 1, 1882, amount available.....	\$3,665 90
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	3,611 21
July 1, 1883, amount available.....	54 09
Amount (estimated) required for completion of existing project.....	60,200 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.....	60,200 00

Statement in detail of annual appropriations, expenditures, customs collected, entrances and clearances, with their tonnage, for Dunkirk Harbor, New York.

Date.	Amount.	Acts approved—	Commercial statistics.			How expended.
			Customs receipts.	Entered and cleared.	Tonnage.	
1827	\$3,000 00	Mar. 3, 1827*	Estimate made. Do. Breakwater extended. Do. Detached breakwater constructed 300 feet long. Estimate for repairs made. Do. Breakwater reported demolished. 250 feet breakwater constructed.
1828	6,000 00	May 19, 1828	.....	.....	.....
1829	9,812 75	Mar. 3, 1829	.....	.....	.....
1830	1,342 75	Apr. 23, 1830	.....	.....	.....
1831	7,102 50	Mar. 2, 1831	.....	.....	.....
1832	10,200 00	July 3, 1832	.....	.....	.....
1834	4,000 00	June 26, 1834	.....	.....	.....
1835	10,988 43	Mar. 3, 1835	.....	.....	.....
1836	11,000 00	July 2, 1836	.....	.....	.....
1837	15,000 00	Mar. 3, 1837	.....	.....	.....
1838	10,000 00	Apr. 3, 1838	Pier construction. Pier repairs, breakwater construction. Pier repairs, breakwater construction and removal of old breakwater. Pier repairs, breakwater construction, and estimate made. Pier repairs, breakwater construction, dredging and survey. Breakwater extension and dredging. Breakwater extension and dredging, and rock excavation. Breakwater extension and rock excavation. Do. Pier repairs and rock excavation. Breakwater extension. Breakwater extension, pier repairs, and removal of wreck. Collection of materials. Breakwater extension.
1842	.....	.....	.....	.....	.....
1844	5,000 00	June 11, 1844†	.....	.....	.....
1848	.....	.....	.....	.....	.....
1852	30,000 00	Aug. 30, 1852	.....	.....	.....
1856	.....	.....	.....	.....	.....
1867	100,000 00	Mar. 2, 1867	\$1,557 37	679	452,925	
1868	.....	.....	.....	.....	.....
1869	2,000 00	April 10, 1869	5,281 78	281	68,856	
1870	25,000 00	July 11, 1870	5,619 00	191	41,824	
1871	25,000 00	March 3, 1871	Breakwater extension and dredging. Breakwater extension and dredging, and rock excavation. Breakwater extension and rock excavation. Do. Pier repairs and rock excavation. Breakwater extension. Breakwater extension, pier repairs, and removal of wreck. Collection of materials. Breakwater extension.
1872	25,000 00	June 10, 1872	2,770 00	93	15,876	
1873	48,132 95	March 3, 1873	1,670 70	105	14,530	
1874	35,000 00	June 22, 1874	136 85	84	29,130	
1875	35,000 00	March 3, 1875	183 00	222	20,514	
1876	18,000 00	Aug. 14, 1876	540 00	120	2,316	
1877	.....	.....	266 48	107	21,181
1878	.....	.....	221 98	118	28,198
1879	2,500 00	March 3, 1879	8 35	107	25,261	
1880	10,000 00	June 14, 1880	33 54	110	25,376	
1881	107 10	80	16,340	Collection of materials. Breakwater extension.
1882	.....	.....	358 70	118	13,618

Total amount appropriated \$449,079 33
 Total amount expended 449,025 29
 Total amount available 54 00

* Between 1826 and 1832 the work done consisted in the prolongation of the pier and breakwater, during which period \$28,489.84 were expended, and at which time the pier was 1,400 feet long, and the breakwater was 2,564 feet long.

† The pier was 1,950 feet long, the breakwater 2,125 feet long, and the detached breakwater 300 feet long, and was all completed by 1838 at a cost of \$38,446.

NOTE.—The entrance to the harbor is through a depression in a solid rock reef which extends the entire length of the harbor, and no change in the depth was effected until the blasting and excavating was done in 1877, which increased the depth about 2 feet, making it about 12 feet deep; most of the expenditures made were for the purpose of affording increased security without enlarging or deepening the harbor, which could only be done at a great expense, owing to its having a rock bed.

APPENDIX M M.

IMPROVEMENT OF THE HARBOR OF BUFFALO, ON LAKE ERIE, AND OF HARBORS ON LAKES ONTARIO AND CHAMPLAIN, AND THE RIVERS NIAGARA AND SAINT LAWRENCE—IMPROVEMENT OF OTTER CREEK, VERMONT, AND GRASS AND TICONDEROGA RIVERS, NEW YORK.

REPORT OF LIEUTENANT-COLONEL HENRY M. ROBERT, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1883, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|-----------------------------------|----------------------------------|
| 1. Buffalo Harbor, New York. | 11. Sackett's Harbor, New York. |
| 2. Niagara River, New York. | 12. Ogdensburg Harbor, New York. |
| 3. Wilson Harbor, New York. | 13. Waddington Harbor, New York. |
| 4. Olcott Harbor, New York. | 14. Grass River, New York. |
| 5. Oak Orchard Harbor, New York. | 15. Plattsburg Harbor, New York. |
| 6. Charlotte Harbor, New York. | 16. Swanton Harbor, Vermont. |
| 7. Pultneyville Harbor, New York. | 17. Burlington Harbor, Vermont. |
| 8. Great Sodus Harbor, New York. | 18. Otter Creek, Vermont. |
| 9. Little Sodus Harbor, New York. | 19. Ticonderoga River, New York. |
| 10. Oswego Harbor, New York. | |

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., August 25, 1883.

SIR: I have the honor to transmit herewith the annual report for the fiscal year ending June 30, 1883, of the river and harbor works and water-level observations in charge of Maj. Walter McFarland until April 30, 1883, since which time they have been in my charge.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

M M 1.

IMPROVEMENT OF BUFFALO HARBOR, NEW YORK.

During the past fiscal year the extension of the breakwater has been carried on by contract, and the repair of the piers and breakwater by hired labor.

Under a contract with Messrs. Hingston & Woods, dated May 27, 1881, five substructures, each 50 feet long and 38 feet wide, were sunk, and, with the four substructures placed in 1881-'82 under the same contract, were covered with eight courses of superstructure, thereby completing the above contract in November, 1882, and giving the breakwater a length of 4,891 linear feet. These crib-substructures were placed upon a foundation formed by excavating a trench to solid material and

width was 50 feet at the bottom, with natural slopes. The top of the foundation was brought to 28 feet below ordinary lake level or zero of the engineer water gauge. This trench, with its artificial foundation, extends about 100 feet beyond the end of the present extension of the breakwater, and probably to the limit of foundation which will be required to be placed in excavation. This limit has been determined by an examination along the line of proposed extension, and was reached within 50 feet of the limit anticipated by the Board of Engineers in 1874.

In 1878-'79 the work reached the point where 22 feet of mud was encountered. Since then the solid substructure has been steadily rising, until, at a point 100 feet in advance of the present extension, a bar of gravel and boulder appears, overlying hard-pan or bed rock. This formation continues as far as borings were taken in 1882, viz, 1,500 feet beyond the end of the present extension.

The cost of the breakwater, as estimated by the Board of Engineers in 1874, was \$250 per linear foot.

The cost since 1879 has been as follows: Under Clark's contract, in 1878, owing to the decline in wages and material, the cost was about \$160 per linear foot. Under Colton's contract, in 1879-'80, as the depth of mud which had to be excavated for foundation was much greater than in previous years, the price rose to \$184 per linear foot. Under Bailey's two contracts, in 1879-'80 and 1880-'81, the price was about \$206 per linear foot. Under Hingston & Woods' contract, 1881-'82, the price was about \$160 per linear foot. These prices include all expenses of every kind, the net cost of the contract price being from 6 per cent. to 10 per cent. less, dependent upon the amount of work done during the fiscal year.

On November 8, 1882, bids were opened for the further extension of the breakwater southward for 1,000 linear feet. Andrew J. Packard was the lowest bidder on iron, and with the approval of the Chief of Engineers, the contract was awarded him under date of December 13, 1882. The iron contracted for has been delivered.

Daniel E. Bailey was the lowest bidder on work and material other than iron, but the officer in charge recommended that the bid be rejected, because the prices bid were too high. The recommendation was approved by the Chief of Engineers, and new proposals for work and material other than iron were invited, under date of December 15, 1882, for 700 linear feet of extension. Daniel E. Bailey was again the lowest bidder, but his prices in the second bid differed from those of the first in only one item, viz, that of white pine, and in that the price was reduced in the second bid only \$1 per 1,000 feet, board measure, making an aggregate reduction of \$590 from the prices named in the first proposal.

For the same reason as in the first case the officer in charge recommended the rejection of Mr. Bailey's second bid, and the postponement of readvertising the work to the summer of 1883. These recommendations were approved by the Chief of Engineers and concurred in by the honorable the Secretary of War.

During the past fiscal year, by hired labor, repairs have been made of the breakwater and the south or light-house pier.

On the breakwater the repairs have consisted in fitting a triangular crib into the angle between the side of the breakwater and the end of the crib partially displaced in 1873, in refilling pockets with stone, in replac-

ing broken and decayed deck joists and planks, and temporarily strengthening 100 linear feet of the breakwater injured by the fall storms.

The repairs to the south pier were commenced in April, 1883, and were in progress at the end of the fiscal year, consisting in the entire renewal of the superstructure for a distance of 335 linear feet and replacing the decayed snubbing-posts.

The fender-piles originally placed along the channel side of the stone work of the south pier are decayed and require renewal. In the pile or catch-sand pier the stone filling has settled considerably, and a number of deck plank require renewal. The superstructure over the northern 1,000 feet of the breakwater was built between 1870 and 1872, and consequently is from eleven to thirteen years old, and shows indications of considerable decay. In the Annual Report for 1882 is the following statement:

For the first 2,924 feet the breakwater has a width of 34 feet; from that point to the end of the part now under contract it is 38 feet wide, and for the next 1,000 feet it is proposed to give it a width of 36 feet. In heavy gales from the westward, when the breakwater is most required as a protection for shipping, the lake rises to 5 or 6 feet above ordinary low water, leaving only 2 or 3 feet of the breakwater, as at present constructed, above water-level over which the waves break. Although this height of water does not last long at a time, it is sufficient to create a heavy sea on the inside of the breakwater, while the soft mud of the bottom is not of a sufficiently consistent quality to prevent vessels dragging their anchors.

In rebuilding the superstructure of the breakwater, now that there is no settlement of the substructure, it would be well to modify the plan by building the superstructure for two-thirds of its width on the land side to a height of only 5 or 6 feet above the water-level, and the outer third, on the lake side, to a height of 12 feet above that level, as has been done with good effect in the east breakwater at Oswego, N. Y. The lower platform would then be high enough for all ordinary weather, while the upper one would shut out the sea, except in such a storm as that of 1844, which, as stated by the Board of Engineers convened in 1845, raised the level of the lake at Buffalo 10 feet. This method would not increase the cost of construction, and the stability, where a firm foundation exists, as in this case, would not be affected. To rebuild the superstructure in this way would cost about \$60 per linear foot.

It is at once proposed to make a careful examination of the northerly 1,000 feet of the breakwater, and to commence such repairs as seem immediately necessary. The unusually high stage of the lake during the present season would add greatly to the cost of a thorough and systematic plan of repair in accordance with the plan ultimately proposed, if carried on this year, and therefore it should be deferred until next season as far as can be done with safety.

The appropriations since 1874 have averaged about \$85,000 a year.

With the completion of the last contract the necessity for artificial foundation no longer exists, and with larger appropriations the pier-extension could be carried on if necessary at more than one point and under more than one contract.

The following statement shows the length of the work as projected by the Board of Engineers of 1874, and the amounts completed and yet to be built:

Buffalo breakwater.	Main break- water.	Shore-arm.	South pile or catch- sand pier.	Total.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>
Proposed by Board of Engineers, 1874	7,600	3,100	1,000	11,700
Completed June 30, 1883	4,891		870	5,761
To be built.....	2,709	3,100	130	5,939

A continuation of the breakwater extension and repairs is the work contemplated during the fiscal year ending June 30, 1885.

July 1, 1883, amount expended during fiscal year, exclusive of

18-, 923 34

outstanding liabilities July 1, 1882.....

\$57,461 86

July 1, 1883, outstanding liabilities.....

10,066 10

67,522 34

July 1, 1883, amount available.....

121,395 2

Amount (estimated) required for completion of existing project.....

1,330,000 00

Amount that can be profitably expended in fiscal year ending June 30, 1885. 300,000 00

Abstract of proposals for extension of Buffalo breakwater, New York, received and opened at the United States Engineer office, Oswego, N. Y., at 11 o'clock a. m., November 8, 1882, under advertisement of October 2, 1882.

[Approximate quantities.]

No.	Names and addresses of bidders.	Hemlock, B. M., 2,000,000 feet.	White pine, B. M., 800,000 feet.	White oak, B. M., 50,000 feet.	Stone filling, 34,000 cubic yards.	Screw-bolts, 19,000 pounds.	Drift-bolts, 220,000 pounds.	Splikes, 14,000 pounds.	Riprap, 1,200 cubic yards.	Total.
		Pr. M.	Pr. M.	Pr. M.	Pr. yd.	Per lb.	Per lb.	Per lb.	Pr. yd.	
1	Frank Wilson Cleveland, Ohio					\$0 02.79	\$0 02.60	\$0 03.19		\$9,774 79
*2	Andrew J. Packard, Buffalo, N. Y.					02.47½	02.67½	02.4		9,684 25
3	Pascal P. Pratt and Edward P. Beala, Buffalo, N. Y.					03.50	02.9	03.50		10,435 00
4	Fowler & Sons, Buffalo, N. Y.					03.7	02.8	03.50		10,153 00
15	Daniel E. Bailey, Buffalo, N. Y.	\$20	\$30	\$40	\$150				\$3	121,500 00
16	David W. McConnell, Buffalo, N. Y.	21	32	41	160				3	128,619 00
17	Edward J. Hingston, Buffalo, N. Y.	22	35	40	160				5	135,450 00

* Accepted.

† Rejected.

Abstract of proposals for extension of Buffalo breakwater, New York, received and opened at the United States Engineer office, Oswego, N. Y., at 11 o'clock a. m., December 15, 1882, under advertisement of November 22, 1882.

[Approximate quantities.]

No.	Names and addresses of bidders.	Hemlock, B. M., 1,430,000 feet.	White pine, B. M., 500,000 feet.*	White oak, B. M., 34,000 feet.*	Stone filling, 25,000 cubic yards.	Riprap, 1,000 cubic yards.	Total.
		Per M.	Per M.	Per M.	Per yd.	Per yd.	
1	Edward J. Hingston, Buffalo, N. Y.	\$22 00	\$35 00	\$40 00	\$1 50	\$5 00	\$85,870
2	George Kellogg, Fulton, N. Y.	25 00	35 00	50 00	1 50	5 00	100,000
3	Willis S. Nelson, Fulton, N. Y.	22 00	32 00	45 00	1 60	5 00	94,670
4	David W. McConnell, Buffalo, N. Y.	20 00	29 50	39 50	1 50	5 00	87,840
5	Daniel E. Bailey, Buffalo, N. Y.	20 00	29 00	40 00	1 50	5 00	87,570

* Timber, duty free.

All bids rejected.

The following statement of the commerce of the port of Buffalo, N. Y., for the fiscal year ending June 30, 1883, is, through the courtesy of the collector of customs, furnished from the records of the custom-house:

Revenue from customs.....	\$968,468 47
Value of imports.....	\$5,106,302 00
Value of exports.....	\$470,969 00
Number of vessels cleared.....	3,043
Their tonnage.....	2,016,600
Number of vessels entered.....	3,037
Their tonnage.....	2,005,930
Probable number of arrivals and departures of vessels which do not enter or clear.....	200

Chief articles of commerce: Lumber, grain, coal, and general merchandise.

M M 2.

IMPROVEMENT OF NIAGARA RIVER AT TONAWANDA, NEW YORK.

No work has been done during the past fiscal year, and available funds will be held for such application as may be necessary to the further improvement of the channel by removing obstructions which may form in them from time to time.

The Senate bills 2373, 2374, and 2375, Forty-seventh Congress, authorized the construction of bridges across the Niagara River as follows:

One at a point between Niagara Falls and Mountain Ridge, above Lewiston, N. Y., to the Niagara Bridge Company; one at Lewiston, N. Y., to the Lewiston and Ontario Bridge Company; and one at Tonawanda, N. Y., to the Niagara Grand Island Bridge Company.

These bills were referred to Maj. Walter McFarland, Corps of Engineers, for consideration and remark by the Chief of Engineers, and returned with the indorsement that—

The two lower bridges will not affect the shipping interests of the river, and the upper one, though interfering somewhat with the passage of lumber rafts to Tonawanda, will not, or should not, be more of an obstruction than the International Bridge at Black Rock.

The material dredged by the city of Buffalo from the river was formerly dumped on the Horseshoe Shoal in front of the city. The present season the city required the dredged material to be dumped in the Niagara River below the city water-works crib. The Tonawanda Lumbermen's Association protested against this action to the Secretary of War, claiming that the dredged material was being deposited where it was shoaling the up-stream channel. The city of Buffalo, upon the request of the United States district attorney, changed back to their old dumping-ground.

The correspondence upon the subject, including a report by Assistant Engineer Maurice Kingsley, is appended hereto, as it may be of service in the future in case the objectionable practice is ever resumed.

No appropriation is asked for further improvement, the work contemplated having been completed.

Money statement.

Amount appropriated by act passed August 2, 1882.....	\$1,500 00
July 1, 1883, amount available.....	1,500 00

1936 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

PROTEST OF TONAWANDA LUMBERMEN'S ASSOCIATION.

TONAWANDA, N. Y., June 14, 1883.

DEAR SIR: At a meeting of the Tonawanda Lumbermen's Association, held this day, it was resolved that a protest be sent the Secretary of War protesting against the action of the city of Buffalo in dumping the dredging from Buffalo Harbor into Niagara River directly into the channel to this port.

The alleged reason for the city's dumping below the water-works crib is, that dumping above on the shoals renders the water impure for city use. It is the almost universal testimony of practical men that all the debris from the old dumping-grounds and Buffalo Creek hugs the Bird Island Pier and does not extend out into the river to within 300 feet of the crib. Material dumped below the water-works crib is more likely to be detrimental to the channel below than if dumped on the old dumping-ground on the Horseshoe Reef Shoals.

The dredging is now being dumped in an eddy that all vessels going up the river take advantage of, and dumping in it will in all probability shoal it materially.

We represent an important interest now endangered by this official order from the city of Buffalo, to dump 60,000 cubic yards of solid material directly in the channel of Niagara River, through which move vessels annually transporting 500,000,000 feet of lumber.

Alarmed at this ill-advised action by the city of Buffalo, we do earnestly protest, and ask from you such prompt attention and orders, even by telegraph to the United States engineer in charge, as its importance demands.

With great respect, yours,

JAMES R. SMITH,
President Tonawanda Lumbermen's Association.

HON. ROBERT T. LINCOLN,
Secretary of War.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
June 19, 1883.

Respectfully referred to Lieut. Col. Henry M. Robert, Corps of Engineers, for report. To be returned.

JOHN G. PARKE,
Acting Chief of Engineers.

[Second indorsement.]

UNITED STATES ENGINEER OFFICE,
Onwego, N. Y., June 23, 1883.

Respectfully returned to the Chief of Engineers.

The result of my investigation of this subject is to confirm the statements made in this protest of the Tonawanda Lumbermen's Association. I understand that the material dredged, both by the State and by private parties, is still being dumped on the old dumping-ground at the shoals, where the current carries it away; and it seems to me that the new practice of dumping in an eddy where the material will be apt to remain and obstruct the up-stream channel, is a positive injury to navigation, and should be prohibited.

As the writer of the protest desires immediate action, I return this paper, with my opinion as above, intending hereafter to forward to the Chief of Engineers a fuller report upon the subject.

HENRY M. ROBERT,
Lieut. Col. of Engineers.

LETTER OF HON. MARTIN I. TOWNSEND, UNITED STATES DISTRICT ATTORNEY, TO THE MAYOR OF THE CITY OF BUFFALO.

BUFFALO, N. Y., July 18, 1883.

SIR: I have been directed by the honorables the Secretary of War and the Attorney-General of the United States to take such steps as may be found necessary to prevent the injury now being done to the navigation of the American channel of the Niagara River below the city of Buffalo and between the city of Buffalo and Tonawanda. This injury is being done by the depositing of the material dredged by certain parties under contract with the city of Buffalo up at a point opposite some portion of the city near what is known as the water-works crib and at points where the water is nearly still or the current tending towards the easterly shore of the river. In both cases the material dumped is placed in a condition to render the water more shallow in the very channel where the navigation on the American side is all compelled to pass.

You know that the Government has expended and is still expending to improve navigation large amounts of money both at Buffalo and Tonawanda, and is extremely

thorities without a resort by me to civil or criminal prosecutions against the men engaged in the work, and for that reason I respectfully request the attention of yourself and the authorities of your city to the matter referred to.

I came from my own home at Troy for the purpose of seeing you personally in regard to this matter, and after having been accorded a pleasant interview with you, I have now concluded to place my request in writing, as it will be impracticable for me to address the other authorities of the city personally.

I am, very respectfully, yours,

MARTIN I. TOWNSEND,
United States Attorney.

Hon. JOHN B. MANNING,
Mayor of Buffalo.

**ACTION BY THE CITY AUTHORITIES OF BUFFALO, NEW YORK, ON THE LETTER OF
HON. MARTIN I. TOWNSEND, UNITED STATES ATTORNEY.**

Alderman Rupp, from the committee on wharves, harbors, and ferries, reported in favor of the adoption of the following resolution:

"That Hingston & Woods be, and they are hereby, authorized to hereafter dump all dredged matter on the old dumping-ground, or Horseshoe Reef, in accordance with their proposition of March 22, 1883, viz, at a reduction of 10 cents per cubic yard for each and every cubic yard deposited on said Horseshoe Reef; and the engineer is hereby authorized to make such modifications in the present contract."

Adopted.

**REPORT OF MR. MAURICE KINGSLEY, ASSISTANT ENGINEER, ON THE PROTEST OF THE
TONAWANDA LUMBERMEN'S ASSOCIATION AGAINST THE DUMPING OF MATERIAL IN
THE NIAGARA RIVER.**

BUFFALO, N. Y., July 24, 1883.

COLONEL: I respectfully submit herewith a detailed report upon the protest, dated June 14, 1883, from the Tonawanda Lumbermen's Association against the city of Buffalo dumping dredged material in the Niagara River. I have delayed forwarding it in hopes of being able to get further data; but as the district attorney has already taken steps in the matter, I did not deem it advisable to delay longer.

The dumping-ground used hitherto at Buffalo has been at a point on the Horseshoe Reef Shoals about one-half a mile north of the north end of the Buffalo breakwater (see sketch). These shoals have an area of about 3 square miles, a depth of water over them of from 18 to 3 feet, and a current at the south or harbor side of about 2 miles per hour, increasing at the north or riverside to about 5 miles per hour. In winter and spring they are swept by ice.

The city of Buffalo obtains its water-supply from the Niagara River, about half-way between these shoals and the International Railroad Bridge at Black Rock. A supply-pipe is laid under the Erie Canal to an inlet crib 550 feet out in the river; besides this there is a valve-inlet in the pipe where it crosses the pier which protects the Erie Canal, and which can be used in case of damage to the other.

The crib was originally located with the double view of giving a good channel between it and the pier for vessels, and assuring a pure water-supply by being outside the run of dirt and refuse coming down the river from freshets in Buffalo Creek.

During last winter, for some days in succession, the city water was very dirty, and one of the aldermen found that the inlet-valve on the pier had been open. The matter was brought up in the common council, but the water commissioners denied that the valve had been tampered with. There ensued a long argument, in which the testimony of experts was brought forward to prove that the dirty water supplied by the city must have come through the valve, as that it was their opinion the dirty water from the creek never approached nearer to the crib than 300 feet. The matter ran on for several weeks, and was finally tabled.

This spring, however, the city, in making its annual dredging contracts, put in the proviso that the scows should be dumped below the Water Works Crib in the Niagara River, and not on the old dumping-ground, alleging that the refuse dumped there would sully the water of the river at the inlet crib. But there was another clause in the contract that, if it was found advisable to change back to the old dumping-ground at any time, the contractor was to do it, a deduction of 10 cents per cubic yard being made from the existing price on account of the shorter distance which the scows would have to be towed.

The estimated amount of city dredging this year is 60,000 cubic yards of material, the majority of which is very soft mud, sawdust, and dirt of all kinds which settles

in and around the slips and in the stiller portions of the creek. There is also a little gravel being dredged, but I am informed that this is dumped on the old dumping-ground only. Unless a man was set to watch each scow-load it would be impossible to verify this.

At the same time the State is doing some dredging, estimated at about 20,000 cubic yards, and dredging is being done by private parties to the amount of 20,000 cubic yards (estimated).

Curiously enough, the city allows the State and private dredging to be all dumped on the old dumping-ground still; while probably all their own dredging they require to be dumped below the Water Works Crib.

The material is of a similar quality in all three cases, and it is hard to believe that material dredged by the State and private parties would be less detrimental to the water-supply of the city than that dredged by the city itself.

Since this matter came up last winter I have watched closely the run of water from Buffalo Creek (clearly distinguishable from the Niagara River water in time of freshets) and the run of ice from off the shoals around the old dumping-ground, and I am of the opinion that the dirty water from Buffalo Creek never gets to within 200 feet of the Water Works Crib, and that from the run of the ice most of the *débris* carried down by ice from the old dumping-ground comes inside the crib, the balance being so small a quantity that it would be absolutely unappreciable in the enormous amount of water which passes the crib daily. The estimated current at the crib itself is 7 miles per hour, the cross-section of the river being about 1,400 by 15 feet.

The eastern end of Lake Erie is very shallow, and every southwesterly storm (which is the prevailing and heaviest) brings a large amount of sand and silt with it. I delayed this report in order to get a few samples of this water and calculate the solid material in a cubic foot of water, but there has been no heavy storm lately.

The amount of sediment in the Mississippi at New Orleans is estimated at one part of solid material to one thousand three hundred and sixty of water. Assuming the amount in a heavy storm of Lake Erie to be one-fifth of this for the Niagara River, which I consider a fair estimate, we have one part solid material in six thousand eight hundred of water.

The current of the river across past the Water Works Crib may be estimated at 5 miles per hour, though at the crib itself and in towards the east bank it is estimated at 7 miles; the cross-section of the river may be taken at 1,400 by 15 feet, which would give about 70,000 cubic yards of solid material passing down the river in twenty-four hours during a storm, or seven-tenths of the whole amount of material dredged this year at Buffalo.

As with the dredged material, a large portion of this must be disintegrated in its passage down the river; another portion goes over the falls, and, judging from the trend of the currents, I should judge that from one-third to one-half of that which passes the crib goes down the western or Canadian channel of the river, and never touches Tonawanda or the channel above it, as far as the head of Strawberry Island, 1 mile below the International Railroad Bridge at Black Rock.

It would, therefore, seem to matter little whether the material was dumped on the old ground or in mid-channel of the Niagara River below the Water Works Crib; but in order to take advantage of the slack-water close along the pier, in towing up the river again, after the scows have been dumped, the tug men dump well over on the American side close to the pier, and sometimes in the slack-water itself. The current in this slack-water varies from nothing to 2 miles per hour, and runs from 20 to 50 feet out into the stream, while outside of it the current runs from 5 to 7 miles per hour.

All the vessels coming up from below take advantage of this eddy; indeed it is a question if a tow could get up without it.

And while it would be at present impossible to tell if this part of the channel is shoaling, there can be little doubt but what there will be a marked shoaling in a few years, especially if they are allowed to dump any gravel there.

In order to insure dumping in mid-channel it would be necessary to have an inspector always on hand there, which, even if effective, would be expensive to the Government.

Seeing, then, no reason why the city should not dump on the old ground, and that the chances are that the eddy along the pier will be filled up if the city are allowed to dump there, I respectfully indorse the protest of the Lumbermen's Association of Tonawanda, and should advise that steps be taken to force the city back upon the old dumping-grounds on Horseshoe Reef. This can be done without either detriment to the city or contractor, on account of the special clause in the contract.

The name of the firm doing the dredging for the city is Hingston & Woods, of Buffalo.

Very respectfully, your obedient servant,

MAURICE KINGSLEY,
Assistant Engineer.

Lieut. Col. HENRY M. ROBERT,
Corps of Engineers, U. S. A.

COLONEL: An examination, made yesterday by a diver in the employ of the city of Buffalo of the inlet of the Water Works Crib in the Niagara River, through which the city obtains its water-supply, showed that there was a considerable deposit of gravel and stones in the mouth of the tunnel. On the sketch accompanying my report of July 24 it will be seen that in 1875 the 18-foot curve extended far out from the shore to the crib, with deeper water above and below it.

There must be more or less of an eddy above and below this bar, and a tendency to shoal on it and round it. I think this fact strengthens the argument against dumping at or near this point, and would respectfully suggest it be noticed in your report to the Chief of Engineers.

Very respectfully, your obedient servant,

MAURICE KINGSLEY,
Assistant Engineer.

Lieut. Col. HENRY M. ROBERT,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The following statement of the commerce of the port of Tonawanda, N. Y., for the fiscal year ending June 30, 1883, is, through the courtesy of the collector of customs, furnished from the records of the custom-house:

Revenue from customs	\$40,327 00
Value of imports	\$527,599 00
Value of exports	\$32,000 00
Number of vessels cleared	939
Their tonnage	337,894
Number of vessels entered	940
Their tonnage	337,940

Chief article of commerce, lumber.

M M 3.

IMPROVEMENT OF WILSON HARBOR, NEW YORK.

During the past fiscal year, under a contract with Andrew J. Packard, dated December 13, 1882, the iron required for 240 linear feet of pier extension was delivered. Under a contract with William J. Harris, dated December 20, 1882, three cribs, or 90 linear feet of pier work, were placed in the extension of the west pier.

An examination made early in the present season developed the fact that two bars had formed across the channel, upon which there was only 7½ feet of water at low water. An arrangement was made with Messrs. Lee and Dunbar, by the hire of dredge, to reopen a channel 70 feet wide along the west pier. This work was completed by the removal of 3,473 cubic yards.

The operations during the present season will be the completion of the present contract for pier-extension, under which five cribs remain to be placed, and the superstructure over 240 linear feet of crib substructure is still to be built. Such minor repairs by hired labor will be made as are demanded for the preservation of the work.

Continuation of pier-extension, dredging, and repair is the work contemplated during the fiscal year ending June 30, 1885.

July 1, 1883, amount available 7,945 00

Amount (estimated) required for completion of existing project..... 50,000 00
 Amount that can be profitably expended in fiscal year ending June 30, 1885. 30,000 00

Abstract of proposals for extension of piers at Wilson Harbor, New York, received and opened at the United States Engineer office, Oswego, N. Y., at 11 o'clock, November 4, 1882, under advertisement of October 3, 1882.

[Approximate quantities.]

No.	Names and addresses of bidders.	Hemlock, B. M., 120,000 feet.	White pine, B. M., 91,000 feet.	White oak, B. M., 600 feet.	Stone filling, 2,000 cubic yards.	Screw-bolts, 3,600 pounds.	Drift-bolts, 20,000 pounds.	Spike, 1,700 pounds.	Total.
		<i>Pr. M.</i>	<i>Pr. M.</i>	<i>Pr. M.</i>	<i>Pr. yd.</i>	<i>Per yd.</i>	<i>Per lb.</i>	<i>Per lb.</i>	
1	Pascal P. Pratt and Edward P. Beals, Buffalo, N. Y.	-----	-----	-----	-----	\$0 03.90	\$0 03.30	\$0 04	\$868 40
*2	Andrew J. Packard, Buffalo, N. Y.	-----	-----	-----	-----	03.75	02.87½	03.75	773 75
3	Fowler & Sons, Buffalo, N. Y.	-----	-----	-----	-----	03.90	03	03.70	803 28
*4	William J. Harris, East Avon, N. Y.	\$22 00	\$26 00	\$40 00	\$1 50	-----	-----	-----	8,162 00
15	W. S. Nelson and Porter H. Hyde, Fulton, N. Y.	28 00	35 00	50 00	1 25	-----	-----	-----	9,243 00
6	J. W. Dennis, Buffalo, N. Y.	25 00	33 00	60 00	2 50	-----	-----	-----	11,189 00
7	David W. McConnell, Buffalo, N. Y.	24 50	32 00	50 00	1 80	-----	-----	-----	9,629 00

* Accepted.

† Included in bid for iron, which should be separate.

COMMERCIAL STATISTICS.

The following statement of the commerce of the port of Wilson, N. Y., for the fiscal year ending June 30, 1883, is, through the courtesy of the collector of customs, furnished from the records of the custom-house:

Revenue from customs..... \$1,569 15
 Value of imports..... \$13,177 00
 Number of vessels cleared..... 26
 Their tonnage..... 2,400
 Number of vessels entered..... 29
 Their tonnage..... 2,713
 Probable number of arrivals and departures of vessels which do not enter
 or clear..... 20
 Chief articles of commerce: Lumber and shingles.

M M 4.

IMPROVEMENT OF OLCOTT HARBOR, NEW YORK.

No expenditures were made in the fiscal year ending June 30, 1883, as no funds were available.

The piers have been carried to about the 9-foot curve in the lake, and the present depth of water in the channel is about 7½ feet. The super-

and systematic repair.

To carry into effect the original project will probably require all of the unappropriated balance of the original estimate, leaving the cost of necessary repairs to be provided for by an additional estimate.

A continuation of pier extension and maintenance and dredging is the work contemplated during the fiscal year ending June 30, 1885.

Money statement.

Amount (estimated) required for completion of existing project..... \$30,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885. 30,000 00

COMMERCIAL STATISTICS.

The following statement of the commerce of the port of Olcott, N. Y., for the fiscal year ending June 30, 1883, is, through the courtesy of the collector of customs, furnished from the records of the custom-house:

Revenue from customs	\$163 60
Value of imports.....	\$51 00
Value of exports	\$2,530 00
Number of vessels cleared	35
Their tonnage	5,949
Number of vessels entered	34
Their tonnage	5,945
Probable number of arrivals and departures of vessels which do not enter or clear.....	35

Chief articles of commerce: Fruit and grain.

M M 5.

IMPROVEMENT OF OAK ORCHARD HARBOR, NEW YORK.

The work designed to be done under the last appropriation is limited to repairs.

During the past fiscal year no work has been done on account of the continued high water rendering repairs nearly impossible. The superstructure of the west pier, though old, is in fair condition, that of the east pier is decayed and has settled in places, and much of the stone has been washed out. These repairs will not be undertaken until next season, and will probably quite absorb available funds.

Pier extension and dredging is the work proposed during the fiscal year ending June 30, 1885.

A railroad has been lately projected between Batavia and Oak Orchard, with direct communication with the Pennsylvania coal fields, and opening a coal trade with Canadian ports, the return vessels carrying lumber and barley. This would make Oak Orchard a harbor of considerable importance. The general commerce of the lake would also be benefited, since Oak Orchard is the only harbor between the mouth of Niagara River and Charlotte, a distance of 80 miles, suitable for a harbor of refuge.

The original project for the improvement of this harbor recognized its position as of value in this latter connection.

A continuation of pier extension and maintenance, with such dredging as may be necessary, is the work contemplated during the fiscal year ending June 30, 1885.

Amount appropriated by act passed August 2, 1882.....	\$3,000 00
July 1, 1883, amount available.....	3,000 00
Amount (estimated) required for completion of existing project.....	97,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.....	40,000 00

COMMERCIAL STATISTICS.

The following statement of the commerce of the port of Oak Orchard, N. Y., for the fiscal year ending June 30, 1883, is, through the courtesy of the collector of customs furnished from the records of the custom-house:

Revenue from customs.....	\$2,607 00
Value of imports.....	\$21,520 00
Number of vessels cleared.....	21
Their tonnage.....	1,508
Number of vessels entered.....	21
Their tonnage.....	1,508
Probable number of arrivals and departures of vessels which do not enter or clear.....	55

Chief articles of commerce: Lumber, shingles, lath, posts, coal, and grain.

M M 6.

IMPROVEMENT OF CHARLOTTE HARBOR, NEW YORK.

During the past fiscal year, under a contract with Andrew J. Packard, dated December 13, 1882, all the iron required for 600 linear feet of pier extension was delivered. January 23, 1883, a contract was made with J. W. Dennis for workmanship and all material, except iron, required for twenty cribs, or 600 linear feet of extension. At the close of the fiscal year four crib substructures had been placed in the extension of the west pier under this contract.

The operations during the present season will be the completion of the existing contract for pier extension, under which sixteen cribs will be placed and superstructure built over 600 linear feet of substructure.

Continuation of pier extension, dredging, and repairs is the work contemplated during the fiscal year ending June 30, 1885.

About 1,300 linear feet of the superstructure of the east pier is in a very decayed condition, and absolutely requires to be rebuilt within two years, at an estimated cost of \$20,000.

The superstructure over the west pier, although in better condition than the east, will require to be rebuilt in three years, at an estimated cost of \$25,000. These extensive repairs are in addition to the amount required for the completion of the existing project.

Charlotte Harbor is the port of entry for the city of Rochester, the fifth city in population in the State of New York, and its facilities should be increased by extending the piers to the 15-foot curve in the lake, and by deepening the channel between the piers to 15 feet, so as to admit vessels drawing 14 feet, the largest that will be able to pass through the Welland Canal when completed. The urgent requirements of repairs and the commercial importance of this harbor seem to warrant sufficient appropriations to rapidly push this work to completion.

Money statement.

July 1, 1882, amount available.....	\$680 68
Amount appropriated by act passed August 2, 1882	35,000 00
	<hr/> 35,680 68
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	3,628 86
	<hr/> 32,051 82
July 1, 1883, amount available.....	
Amount (estimated) required for completion of existing project.....	119,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	80,000 00

Abstract of proposals for extension of piers at Charlotte Harbor, New York, received and opened at the United States Engineer office, Oswego, N. Y., at 11 o'clock a. m., November 8, 1882, under advertisement of October 4, 1882.

[Approximate quantities.]

No.	Names and addresses of bidders.	Hemlock, B. M., 307,000 feet.	White pine, B. M., 183,000 feet.	White oak, B. M., 1,200 feet.	Stone filling, 9,880 cubic yards.	Dredging, 5,000 cu- bic yards.	Screw-bolts, 7,200 pounds.	Drift-bolts, 45,000 pounds.	Spike, 3,500 pounds.	Total.
1	Pascal P. Pratt and Edward P. Beale, Buffalo, N. Y.						\$0.03.65	\$0.03	\$0.03.60	\$1,735 20
*2	Andrew J. Packard, Buffalo, N. Y.						03.625	02.79	03.625	1,643 37
3	Fowler & Sons, Buffalo, N. Y.						03.9	03	03.7	1,760 30
4	Frank Wilson, Cleveland, Ohio						03.99	02.89	3.39	1,706 43
15	William J. Harris, East Avon, N. Y.	\$25 00	\$30 00	\$50 00	\$1 50					28,045 00
16	George Kellogg, Fulton, N. Y.	22 00	30 00	60 00	1 75	\$0 50				32,206 00
*7	J. W. Dennis, Buffalo, N. Y.	22 00	28 50	50 00	1 70	50				31,825 50
8	David W. McConnell, Buffalo, N. Y.	22 20	31 00	60 00	1 78	55				32,896 80

* Accepted.

† Rejected; no bid for dredging.

‡ Timber, duty free.

COMMERCIAL STATISTICS.

The following statement of the commerce of the port of Charlotte, N. Y., for the fiscal year ending June 30, 1883, is, through the courtesy of the collector of customs, furnished from the records of the custom-house:

Revenue from customs	\$115,888
Value of imports	\$710,960
Value of exports	\$304,485
Number of vessels cleared	578
Their tonnage	114,437
Number of vessels entered	549
Their tonnage	108,758
Probable number of arrivals and departures of vessels which do not enter or clear	125

Chief articles of commerce: Barley, pease, lumber, live stock, shingles, lath, iron ore, and coal.

IMPROVEMENT OF PULTNEYVILLE HARBOR, NEW YORK.

During the past fiscal year, under a contract with Andrew J. Packard, dated December 13, 1882, the iron required for 60 linear feet of pier extension was delivered.

A contract with William J. Harris was entered into on December 20, 1882, for workmanship and material, except iron, required for the construction of 60 linear feet of pier extension.

Operations during the present season will consist in placing two crib substructures and building superstructures over the same under the above-mentioned contract.

The appropriation of \$4,000, made by act of August 2, 1882, completed the amount of the estimate for the project under which work has been done.

As no comprehensive survey has been made since 1873, it is proposed to make one during the present season and submit the results and conclusions in a later report.

Money statement.

Amount appropriated by act passed August 2, 1882	\$4,000 00
July 1, 1883, amount expended during fiscal year	451 41
July 1, 1883, amount available	3,548 59
Amount that can be profitably expended in fiscal year ending June 30, 1885	2,000 00

Abstract of proposals for extension of west pier at Pultneyville Harbor, New York, received and opened at the United States Engineer office, Oswego, N. Y., at 11 o'clock a. m., Wednesday, November 8, 1882, under advertisement of October 5, 1882.

[Approximate quantities.]

No.	Names and addresses of bidders.	* Hemlock, 46,000 feet, B. M.	* White pine, 27,000 feet, B. M.	* White oak, 240 feet, B. M.	Stone filling, 1,000 cubic yards.	Screw-bolts, 1,000 pounds.	Drift-bolts.		Spike, 500 pounds.	Total.
		Per M.	Per M.	Per M.	Per yd.	Per lb.	30 by 1½ inches, 6,000 pounds.	24 by 1½ inches, 1,000 pounds.	Per lb.	
1	William J. Harris, East Avon, N. Y.	\$25 00	\$30 00	\$50 00	\$1. 50					3,472 00
2	David W. McConnell, Buffalo, N. Y.	24 00	32 00	50 00	1. 80					2,789 00
3	Andrew J. Packard, Buffalo, N. Y.					\$0 03½	\$0 02½	\$0 02½	\$0 63½	261 12
4	Edward P. Beals & Pascal P. Pratt, Buffalo, N. Y.					04	03½	03½	04½	396 25

* Timber, duty free.

† Accepted.

The following statement of the commerce of the port of Pultneyville, N. Y., for the fiscal year ending June 30, 1883, is, through the courtesy of the collector of customs, furnished from the records of the custom-house:

Revenue from customs	\$518 00
Value of imports	\$4,523 00
Number of vessels cleared	14
Their tonnage	813
Number of vessels entered	15
Their tonnage	830
Probable number of arrivals and departures of vessels which do not enter or clear	20

Chief articles of commerce: Lumber, salt, shingles, fruit, and grain.

M M 8.

IMPROVEMENT OF GREAT SODUS HARBOR, NEW YORK.

During the past fiscal year, under a contract with Andrew J. Packard, dated December 13, 1883, all the iron required for the construction of 450 linear feet of pier extension was delivered. Under a contract with George Kellogg & Co., dated December 15, 1882, for the building and placing of eleven cribs and superstructure or 330 linear feet of pier extension, the foundations for the cribs have been prepared and the construction of the cribs are well in progress. Under an agreement made with George Kellogg & Co., for the excavation of one cut through the channel to a depth of 14 feet at low water, 1,245 cubic yards have been removed, at a cost of 20 cents per cubic yard.

The operations during the present season will be the completion of the contract for pier extension, under which eleven cribs are to be placed and superstructure built over 330 linear feet of substructure and the removal of about 2,750 cubic yards of sand from the channel. The dredging which has been done in the past has been confined to the west half of the space between the piers, and since the depth between the piers outside of this dredged channel is very shallow it is difficult to maintain the requisite depth in the channel.

This harbor is of more than local importance, and possesses great natural advantages, with a bay about 4 miles long and 3 miles wide, entirely protected by natural and artificial barriers from the storms of the lake.

The harbor was used during the war of 1812 as one of the bases of supplies for the army operating on the Niagara frontier, and was considered by the Board of Engineers which examined the lake harbors in 1829 as of the first importance from a military and commercial standpoint.

Continuation of pier extension and repairs and dredging are the operations contemplated during the fiscal year ending June 30, 1885.

Money statement.

Amount appropriated by act passed August 2, 1882	\$25,000 00
July 1, 1883, amount expended during fiscal year	\$2,374 83
July 1, 1883, outstanding liabilities	1,072 63
	<u>3,447 46</u>
July 1, 1883, amount available	<u>21,552 54</u>
Amount (estimated) required for completion of existing project	75,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885	40,000 00

[Approximate quantities.]

No.	Names and addresses of bidders.	* Hemlock, 190,000 feet, B. M.	* White pine, 137,000 feet, B. M.	* White oak, 840 feet, B. M.	Stone filling, 7,000 cubic yards.	Dredging, 3,700 cubic yards.	Screw-bolts, 5,400 pounds.	Drift-bolts, 30,000 pounds.	Spike, 2,600 pounds.	Total
		<i>Per M.</i>	<i>Per M.</i>	<i>Per M.</i>	<i>P. yd.</i>	<i>P. yd.</i>	<i>Per lb.</i>	<i>Per lb.</i>	<i>Per lb.</i>	
11	George Kellogg & Co., Fulton, N. Y.	\$22 00	\$30 00	\$60 00	\$1 30	\$0 50				\$12,290 40
2	J. W. Dennis, Buffalo, N. Y.	23 00	31 00	60 00	1 40	50				20,317 40
3	David W. McConnell, Buffalo, N. Y.	25 00	31 00	50 00	1 45	50				21,639 00
14	Thomas Hunter, Ster- ling, N. Y.	26 25	36 00	50 00	1 35					19,411 50
15	William J. Harris, East Avon, N. Y.	23 00	28 00	50 00	1 30					17,345 00
16	John Kelly, Brooklyn, N. Y.	23 47	29 85	40 00	1 10					16,292 25
7	Andrew J. Packard, Buffalo, N. Y.						\$0 03½	\$0 02½	\$0 03½	1,180 00
8	Pascal P. Pratt and Edward P. Beals, Buffalo, N. Y.						03½	03½	03½	1,266 00
9	Fowler & Sons, Buffalo, N. Y.						04	03	03½	1,213 50
10	Frank Wilson, Cleve- land, Ohio						04½	02½	03½	1,209 40

* Timber, duty free.

† Accepted.

‡ Rejected; no bid for dredging.

COMMERCIAL STATISTICS.

The following statement of the commerce of the port of Sodus Point (Great Sodus), New York, for the fiscal year ending June 30, 1883, is, through the courtesy of the collector of customs, furnished from the records of the custom-house:

Revenue from customs	\$20,971 41
Value of imports	\$110,637 71
Value of exports	\$76,015 00
Number of vessels cleared	89
Their tonnage	11,110
Number of vessels entered	76
Their tonnage	11,446
Probable number of arrivals and departures of vessels which do not enter or clear	40

Chief articles of commerce: Iron ore and malt.

M M 9.

IMPROVEMENT OF LITTLE SODUS HARBOR, NEW YORK.

During the last fiscal year, under a contract with Andrew J. Packard, dated December 13, 1882, all the iron required for the construction of 600 linear feet of pier extension was delivered.

Under a contract with Messrs. Kelly & Bannerman, dated December 13, 1882, for the placing of seventeen cribs and superstructure, or 510 linear feet of pier extension, five cribs were placed in the extension of the west pier.

1948 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

COMMERCIAL STATISTICS.

The following statement of the commerce of the port of Fair Haven (Little Rodus), N. Y., for the fiscal year ending June 30, 1883, is, through the courtesy of the collector, of customs, furnished from the records of the custom-house.

Revenue from customs	\$52,657 84
Value of imports	\$250,000 00
Value of exports	\$226,911 00
Number of vessels cleared	211
Their tonnage	34,575
Number of vessels entered	234
Their tonnage	32,056
Probable number of arrivals and departures of vessels which do not enter or clear.....	69

Chief articles of commerce: Iron ore, malt, and coal.

M M 10.

IMPROVEMENT OF OSWEGO HARBOR, NEW YORK.

During the past fiscal year operations have been confined to the repairs and maintenance of the breakwater, Government wharf, and engineer property. The superstructure over 500 linear feet of the west breakwater was repaired by refilling the work with stone and replacing broken or decayed deck joists, ties, and plank. The stone filling having been displaced from the east end of the east breakwater, the work was repaired by sheathing the interior with vertical plank, fitting a brush mattress inside of the crib, and refilling with stone. The wharf at the old pier reservation was rebuilt for 90 linear feet, and refilled with stone. A new boat shed was built and the boats thoroughly repaired.

During the gale of December 6-8, 1882, the west breakwater was breached for a distance of about 50 feet, removing the decking, stone, and the harbor side of the breakwater to a depth of 5 feet below lake surface. This breach was repaired between the 10th and 21st of December, 1882.

Proposals were received on November 8, 1882, for material and workmanship required for the extension of the east breakwater 280 feet, and the construction of one or more spurs, each 150 feet in length, to the west breakwater.

Frank Wilson was the lowest bidder on the iron, and the contract therefor was entered into December 21, 1882, and the iron delivered to the United States. George Kellogg and Orville J. Jennings were the lowest bidders on work and material other than iron, but their bid being considered too high was rejected upon the recommendation of the officer in charge, and with the approval of the Chief of Engineers.

The work was readvertised, with a reduction of the breakwater extension previously proposed to 175 linear feet, and the construction of one spur 150 feet in length to the west breakwater. Proposals were again received on December 15, 1882, and George Kellogg was the lowest bidder. The prices bid being higher than those in the previous proposal, which had been rejected, the officer in charge recommended the rejection of George Kellogg's second bid and the postponement of readvertising the work to the summer of 1883. These recommendations were approved by the Chief of Engineers and concurred in by the honorable the Secretary of War.

During May, 1883, about 5,000 cubic yards of sand and gravel were dredged from the inner harbor, in the formation of a cut along the old breakwater, 500 feet long 45 feet wide and from 12 to 14 feet deep at

low water. This work was done under the direction of this office, but without any charge to the United States, the material being used to fill a new wharf built by private parties.

The most frequent injury to the breakwater from gales has occurred near the western end of the lake-arm of the west breakwater. The superstructure over this part of the work is from nine to ten years old, and from its age, combined with the fact that this part of the breakwater is subjected to the heaviest seas, it will require in the near future a thorough and systematic repair. A careful examination of this part of the work leads to the belief that with the partial repairs which will be made this season the more complete repair may be postponed.

In the annual report upon this harbor for 1882, occurs this statement in relation to rebuilding the superstructure:

The superstructure of the old part of the west breakwater, which has become so decayed as to be in danger of breaking away during violent gales, needs renewing. In rebuilding it, I think it would be well to adopt the method of construction that has been applied in the east breakwater, that is, to raise the outer third of it to a height of 12 feet above the water level, and to lower the inner part until it is but 2 feet above extreme high water in the lake. No more material would be required in constructing it in this way than in the way in which it was originally built, and as the substructure has ceased to settle, having apparently reached a hard substratum, the stability of the work will not be endangered by the change.

Injury to the breakwater from storms, begins with the breaking or removal of the deck; this is followed by the removal of the stone filling, and this in turn by the forcing off of the timbers of the harbor face and the cross ties, leaving the lake front of the breakwater still standing. The integrity of the whole structure depends upon the unbroken decking, and there seems no better method of preserving the decking from injury than by constructing a high parapet on the breakwater.

The heavy cross-sea which exists at the entrance between the east and west breakwaters is a source of difficulty and danger to vessels entering the harbor. The officer lately in charge proposes to partially remedy this by the construction of two spurs from the west breakwater, 150 feet long each, the first one being 1,000 feet west of the eastern entrance and the second one 2,000 feet still further west. These spurs are to have sloping sides, and to be built to a height of 12 feet above the mean lake level, at an estimated cost of \$30,000 each. Their construction forms a part of the work to be readvertised during the present season. A full discussion of this subject is given in the paper appended to this report.

During the year the Delaware, Lackawanna and Western Railroad Company, or other parties, have constructed in the new harbor formed by the west breakwater a pier carrying a coal trestle. The pier and trestle is about 1,000 feet in length, extending to within 407 feet of the west breakwater, and located with its outer end in about $17\frac{1}{2}$ feet of water at the lowest stage of the lake. The right to so occupy the harbor is questioned by the United States, and the subject has been placed in the hands of the United States district attorney and is understood to be under adjudication by the courts.

During the present season repairs to the east and west breakwaters will be continued by hired labor, and new proposals received for the extension of the east pier and construction of spurs to the west pier.

The work contemplated during the fiscal year ending June 30, 1885, is the continuation of the east breakwater extension, the construction of spurs along the outer face of the west breakwater, and the repairs to the Government piers and to the breakwater.

1950 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Money statement.

July 1, 1882, amount available.....	\$26 52
Amount appropriated by act passed August 2, 1882.....	80,000 00
	<hr/> 80,036 52
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	15,225 61
	<hr/> 64,811 57
July 1, 1883, amount available	
Amount (estimated) required for completion of existing project.....	150,622 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	150,000 00

Abstract of proposals for extension of the Oswego breakwater, Oswego Harbor, New York, received and opened at the United States Engineer Office, Oswego, N. Y., at 11 o'clock a. m., Wednesday, November 8, 1882, under advertisement of October 9, 1882.

[Approximate quantities.]

No.	Names and addresses of bidders.	* Hemlock B. M., 976,000 feet.	* White pine, B. M., 467,000 feet.	* White oak B. M., 21,000 feet.	Stone, 20,000 cubic yards.	Dredging, 4,000 cubic yards.	Elrap, 200 cubic yards.	Screw bolts, 6,000 pounds.	Drift bolts, 900,000 pounds.	S p i k e s, 4,000 pounds.	Total
		<i>Per M.</i>	<i>Pr. M.</i>	<i>Pr. M.</i>	<i>P. yd.</i>	<i>P. yd.</i>	<i>P. yd.</i>	<i>Per lb.</i>	<i>Pr. lb.</i>	<i>Pr. lb.</i>	
†1	George Kellogg, Orville J. Jennings, Fulton, N. Y.....	\$22 00	\$32	\$60	\$1 25	\$0 75	\$3				\$62,576 00
†2	J. W. Dennis, Buffalo, N. Y.....	22 00	33	60	1 35	1 00	3				70,063 00
†3	David W. McConnell, Buffalo, N. Y.....	22 20	32	60	1 50	78	3				71,691 20
†4	Willis S. Nelson, Porter W. Hyde, Fulton, N. Y.....	30 00	36	40	1 30	1 25	5				79,422 00
†5	Frank Wilson, Cleveland, Ohio.....							\$0 2.95	\$0 2.64	2.35	2,927 00
6	Andrew J. Packard, Buffalo, N. Y.....							2.75	2 ½	2.75	2,982 50
7	Fowler & Sons, Buffalo, N. Y.....							2.90	2.90	2.75	2,904 00
8	Pascal P. Pratt, Buffalo, N. Y.....							2.80	2.20	2.90	3,264 00

* Timber, duty free.

† Rejected.

‡ Accepted.

Abstract of proposals for extension of the Oswego breakwater, Oswego Harbor, New York, received and opened at the United States Engineer office, Oswego, N. Y., at 11 o'clock a. m., Friday, December 15, 1882, under advertisement of November 23, 1882.

[Approximate quantities.]

No.	Name and address of bidder.	* Hemlock 744,000 feet, B. M.	* White pine, 350,000 feet, B. M.	* White oak 78,000 feet, B. M.	Stone, 12,000 cubic yards.	Dredging 3,000 yards.	Total
†1	George Kellogg, Fulton, N. Y.....	\$24	\$34	\$55	\$1 25	\$1	\$52,286

* Timber, duty free.

† Rejected.

COMMERCIAL STATISTICS.

The following statement of the commerce of the port of Oswego, N. Y., for the fiscal year ending June 30, 1883, is, through the courtesy of the collector of customs, furnished from the records of the custom-house.

Revenue from customs.....	\$786,423 31
Value of imports.....	\$8,313,713 00
Value of exports.....	\$1,102,244 00
Number of vessels cleared.....	2,361
Their tonnage.....	447,226
Number of vessels entered....	2,371
Their tonnage.....	451,293
Probable number of arrivals and departures of vessels which do not enter or clear.....	300
Chief articles of commerce: Lumber, grain, and coal.	

LETTER OF MAJOR WALTER M'FARLAND, CORPS OF ENGINEERS,
RECOMMENDING THE CONSTRUCTION OF SPURS TO THE WEST BREAK-
WATER AT OSWEGO, NEW YORK.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., April 19, 1883.

GENERAL: I have the honor to send you by express to day a roll containing two sheets of drawings indicating the method which I have to recommend for preventing the accumulated wave which forms against the west breakwater at Oswego from rolling across the mouth of the harbor, endangering vessels seeking to enter it by subjecting them to the action of a heavy beam sea at a critical moment.

The subject has been referred to in my letter to you of February 18, 1882, in relation to the lighting of the harbor, and in my last annual report. I inclose herewith a copy of detailed specifications for the construction of the work proposed and a statement of the reasons for my recommendations.

Very respectfully, your obedient servant,

WALTER MCFARLAND,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

STATEMENT OF THE REASONS FOR ADDING SPURS TO THE WEST BREAKWATER AT
OSWEGO, NEW YORK, AND A DESCRIPTION OF THEIR CONSTRUCTION.

1. The west breakwater at the harbor of Oswego consists of a shore arm about 900 feet long running northerly, and a lake arm about 4,900 feet long running from the outer extremity of the shore arm about north 60 degrees east, terminated at its eastern end by a wing running shoreward about 250 feet.

The entrance to the harbor, 350 feet wide, lies between the eastern end of the west breakwater, and the western end of the east breakwater, which is in course of construction.

2. The prevailing storms on Lake Ontario come from the westward, the gales at times being very severe, producing very heavy seas.

3. These seas, striking the west breakwater at a low angle, are partly deflected and roll along it, and being reinforced by succeeding waves they increase in height as they proceed until they either break and fall over the breakwater, or roll across the entrance to the harbor, subjecting vessels that attempt to enter the harbor at such times to the danger of encountering a beam sea at a very critical moment.

The following extracts from a letter sent to the Chief of Engineers from this office under date of February 18, 1882, in relation to the lighting of the harbor, exhibit the danger which results from this condition of things.

EXTRACTS.

"No fault is to be found with the present system of lighting, so far as the ordinary condition of the weather is concerned; the difficulty occurs during the season of most active operations in the fall, when heavy gales from the westward accompanied with storms of rain and snow prevail, which, with the reaction from the long breakwater render it exceedingly difficult for vessels to make the entrance to the harbor, and to miss it means destruction of vessel and cargo, and almost certain loss of life.

"The difficulty resulting from the reaction from the west breakwater, nearly a mile long, is one that exists at no other harbor on the lakes, for everywhere else the entrance is formed by piers that extend into the lake several hundred yards, and vessels entering have only the natural action of the sea to contend with; while at Oswego the seas coming from the westward and striking the breakwater at a low angle are partly reflected and partly roll along it, accumulating as they go, so that vessels on reaching the entrance have not only the ordinary wave to encounter, but what is far more dangerous, the accumulated wave, which I have myself seen, repeatedly, pass in solid volumes over the tops of the snubbing posts on the east breakwater, 15 feet above the water level.

"It requires no argument to show how delicate and dangerous a matter it is to bring a vessel in through such a beam sea as this in broad daylight with all the help that a well marked shore line can give; and what it is to attempt the same thing at night, when the whole outline of both breakwaters has disappeared from view and but one end of one of them is faintly marked by a light often obscured by rain, sleet, or spray, may be easily imagined.

"It is idle to talk of sailing by ranges in such circumstances. In order to avoid being swept by the trend of the sea against the lee breakwater the vessel must hug the one to windward (usually the west breakwater) as closely as possible, and in view of the impossibility of estimating distances correctly in the dark, there is but one way to make this a safe thing to attempt, and that is by marking both sides of the entrance distinctly.

"It is the common testimony of the vessel masters sailing to this port that during these heavy gales the breakwater cannot be seen at all even during daylight, as it is completely covered by broken water, and the reaction from the breakwater extends this broken water from one-fourth to one-half a mile into the lake.

"A vessel entering this broken water begins to tumble about, steers badly, and becomes to some extent unmanageable, the effect increasing as she nears the entrance, and yet she must manage to stand close to the windward side of the channel or run the risk of being destroyed against the opposite breakwater. * * * The harbor has always been a troublesome one to enter in very bad weather, as it is on the open coast near the eastern end of the lake, and is exposed to the full sweep of the sea coming from the other end 160 miles to the westward. The prevailing winds and the most serious gales are from southwest to northwest. The breakwater runs about northeast to east.

"There have been wrecks here from the earliest days, as vessels missing the entrance would go ashore on the rocks under Fort Ontario. There are records of six or seven being cast ashore there in one night. The number of wrecks has decreased since the formation of an artificial harbor."

The scheme which I propose as offering a partial remedy against the strong cross-current and beam sea which are encountered at the entrance of the harbor in very bad weather, consists of the construction of two or more spurs running lakeward from the west breakwater and at right angles to it.

The first spur is placed well to the westward of the entrance, because it should be out of the way of vessels approaching the entrance from the westward. They are often compelled to hug the breakwater rather closely near its eastern end in making the harbor, and therefore the spur should not be very near the entrance.

At the same time it is near enough to prevent much wave accumulation from the westward at the entrance, and it breaks the current along the breakwater.

To break this current elsewhere, thus preventing too great a shove of the sea against the first spur, other spurs should be put in to the westward.

The general direction of these spurs should be perpendicular to the line of the breakwater, because the storms sometimes come from the north and northeast.

The length of these spurs is put at 150 feet each, which may be increased if found necessary.

The cross-section proposed for these spurs is trapezoidal to give greater stability for the same cost, and to reduce the shock to the structure from the strong current and the broken wave by permitting the water to rush up and pass over the top instead of delivering its entire blow against a vertical wall.

The slope of the sides is secured by setting each 12-inch side timber 6 inches back on the timber below it. The exposed corners will be worn down by the action of the

water and ice, and this and the necessity of arranging for secure bolting requires that these walls should be made double.

Oak is introduced where the action of the ice would be most severe.

Clamping pieces are used, running up and down the cross-walls, in order to hold the horizontal courses more firmly together, and to resist the tearing action of the waves as they roll up the outer slopes.

To enable gravity to act much as possible in resisting the movement of the water over these spurs, and also to make the spurs themselves as conspicuous as possible, their tops are raised to a height of 12 feet above the water-level, and their outer extremities are to be terminated with solid cones, painted white, and running up to the height which the side slopes of the spurs themselves would give, namely, about 17 feet, which would make the apex of each about 29 feet above the water-level. I consider this a necessary safeguard to prevent coasting vessels from running into the spurs.

Respectfully submitted.

WALTER MCFARLAND,
Major of Engineers.

M M II.

IMPROVEMENT OF SACKETT'S HARBOR, NEW YORK.

During the past fiscal year, under a contract with William J. Daly, dated May 5, 1883, 8,510 cubic yards of sand, mud, and gravel were removed from the harbor. The dredging developed the existence of limestone rock in the southern part of the harbor, at a depth of about 12 feet below water, and 1 or 2 feet less at the angle near the Railroad Depot.

During the present season dredging under the existing contract will be completed by the removal of about 15,000 cubic yards additional to the work done prior to June 30, 1883.

A crib about 20 feet square will be placed on the shoal which extends southerly into the harbor from the east end of Ship House Point, for the purpose of defining the shore and the entrance, and also to furnish facilities for mooring vessels while lying in the harbor.

It is desired by those interested in the harbor that it should ultimately be deepened so as to admit the largest vessels that will be able to pass the Welland Canal; that is, vessels drawing 14 feet of water. Should this be required, the present estimates for this harbor would require to be modified, on account of the increased quantities of material to be removed, and also to provide for the excavation of a large quantity of rock. This rock in place prevented the dredging this season from reaching 12 feet depth in a portion of the harbor. With the completion of the dredging of the present contract the harbor will have a depth of 12 feet at low water extending over nearly the whole required area of the harbor, and it seems that the present project for its improvement has been completed so far as can be done without blasting rock in place.

No further appropriation is asked for this harbor.

Money statement.

Amount appropriated by act passed August 2, 1882.....	\$7,000 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$447 18
July 1, 1883, outstanding liabilities.....	1,702 00
	<hr/> 2,149 18
July 1, 1883, amount available	<hr/> 4,850 82
Amount (estimated) required for completion of existing project.....	15,000 00
5455—E 83—123	

1954 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of proposals for improving channel at Sackett's Harbor, N. Y., received and opened at the United States Engineer office, Oswego, N. Y., at 11 o'clock a. m., April 25, 1883, under advertisement of March 12, 1883.

[Approximate quantities.]

No.	Name and address of bidder.	Dredging.		Total.
		Quantity.	Rate.	
1*	William James Daly, Ogdensburg, N. Y.....	Cubic yards. 14,000	Per cu. yd. \$0 20	\$2,800

* Accepted.

COMMERCIAL STATISTICS.

The following statement of the commerce of the port of Sackett's Harbor, N. Y., for the fiscal year ending June 30, 1883, is, through the courtesy of the collector of customs, furnished from the records of the custom-house:

Revenue from customs.....	\$3,430 56
Value of imports.....	\$21,505 00
Value of exports.....	\$9,300 00
Number of vessels cleared.....	177
Their tonnage.....	5,009
Number of vessels entered.....	178
Their tonnage.....	5,068
Probable number of arrivals and departures of vessels which do not enter or clear.....	125

Chief articles of commerce: Grain, coal, fish, cedar posts, hop-poles, lumber, and hay.

M M 12.

IMPROVEMENT OF OGDENSBURG HARBOR, NEW YORK.

During the past fiscal year, under a contract with Franklin Lee, dated December 13, 1882, 9,648 cubic yards of material were removed from the channel between the lower end of the city front and deep water in the Saint Lawrence River, giving a channel 150 feet in width and 15 feet depth at low water.

Operations during the present season will consist in deepening the channel along the Saint Lawrence front of the city.

Continuation of dredging is the work contemplated during the fiscal year ending June 30, 1885.

Money statement.

Amount appropriated by act passed August 2, 1882.....	\$10,000 00
July 1, 1883 amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	\$467 95
July 1, 1883, outstanding liabilities.....	2,122 56
	<u>2,590 51</u>
July 1, 1883, amount available	<u>7,409 49</u>
Amount (estimated) required for completion of existing project.....	66,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	40,000 00

Abstract of proposals for improving at Ogdensburg Harbor, New York, received and opened at the United States Engineer office, Oswego, N. Y., at 11 o'clock a. m., Wednesday, November 8, 1882, under advertisement of October 2, 1882.

[Approximate quantities.]

No.	Names and addresses of bidders.	Dredging.		Total.
		Quantity.	Rate.	
		<i>Cubic yards.</i>	<i>Per cu. yd.</i>	
*1	Franklin Lee, Buffalo, N. Y	50,000	\$0 22	\$11,000
2	John Hannan, Ogdensburg, N. Y	50,000	24	12,000
3	George Kellogg and Orville J. Jennings, Fulton, N. Y	50,000	27	13,500

*Accepted.

COMMERCIAL STATISTICS.

The following statement of the commerce of the port of Ogdensburg, N. Y., for the fiscal year ending June 30, 1883, is, through the courtesy of the collector of customs, furnished from the records of the custom-house:

Revenue from customs	\$159,920 30
Value of imports	\$1,357,008 00
Value of exports	\$675,042 00
Number of vessels cleared	1,341
Their tonnage	293,068
Number of vessels entered	1,475
Their tonnage	326,436
Probable number of arrivals and departures of vessels which do not enter or clear	12,000

Chief articles of commerce: Lumber grain, and merchandise.

M M 13.

IMPROVEMENT OF WADDINGTON HARBOR, NEW YORK.

No work has been done at this harbor during the past fiscal year. No funds were available at the commencement of the year, and none have been appropriated since. As stated in the last Annual Report, the original project has been completed, and there seems to be no good reason for attempting further work at this harbor.

The work already done has secured a channel of navigable width and 11 feet depth at low water, through the bar at the head of Little River, and the channel below the dam has been considerably improved.

No appropriation is asked for.

COMMERCIAL STATISTICS.

The following statement of the commerce of the port of Waddington, N. Y., for the fiscal year ending June 30, 1883, is, through the courtesy of the collector of customs, furnished from the records of the custom-house:

Revenue from customs	\$15,121 61
Value of imports	\$73,962 00
Probable number of arrivals and departures of vessels which do not enter or clear	1,500

Chief articles of commerce: Live stock and lumber.

During the past fiscal year proposals were received for the removal of about 2,000 cubic yards of material at the "Rapids." There being but a single bid at \$6 per cubic yard, it was recommended by the officer in charge, and approved by the Chief of Engineers, that the bid be rejected, for the reason that only about one quarter of the required work could be accomplished by entering into a contract upon this bid, and that the work be deferred until a further appropriation is made for it. If further appropriation is made the work contemplated during the fiscal year ending June 30, 1885, is dredging.

Money statement.

Amount appropriated by act passed August 2, 1882.....	\$3,000 00
July 1, 1883, amount expended during fiscal year	51 40
July 1, 1883, amount available.....	2,948 60
Amount (estimated) required for completion of existing project.....	9,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	9,000 00

M M 15.

IMPROVEMENT OF PLATTSBURGH HARBOR, NEW YORK.

The last appropriation made for this harbor was for \$1,000 by act of June 14, 1880.

During the past fiscal year a survey was made of the harbor in the vicinity of the city front and breakwater. Complaint having been made of the formation of a shoal in front of the city wharves, and the belief having been expressed that its formation was due to the deposit of sawdust brought down the Saranac River, an examination was made August 10, 1882, by Assistant Engineer William P. Judson, which is appended hereto.

A survey made in November, 1882, shows that the 8-foot curve at low water extends about 200 feet east and 500 feet south of the wharf of the Plattsburgh Dock Company, and also that the depth of 8 feet at low water is carried to within 50 feet of the front of the wharf.

The breakwater is in good repair, and the only expenditure required in the near future for maintaining the harbor in condition for the requirements of commerce will be a small amount for dredging, and this is the work contemplated during the fiscal year ending June 30, 1885.

Money statement.

July 1, 1882, amount available.....	\$1,629 00
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	225 05
July 1, 1883, amount available	1,403 95
Amount (estimated) for completion of existing project.....	12,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	5,000 00

REPORT OF MR. WILLIAM P. JUDSON, ASSISTANT ENGINEER.

OSWEGO, N. Y. *August 18, 1882.*

MAJOR: I have the honor to report as follows regarding the present condition of Plattsburgh Harbor from an examination of it, and of the lower 6 miles of the Saranac River, which I made on the 10th instant.

The harbor, which is wholly artificial, consists of a breakwater which shelters three wharves which project into Lake Champlain from the south side or the river's mouth. This breakwater is detached from the shore and is generally parallel to the wharf-front, which it shelters from the east and southeast. The line of heaviest sea is from

M M 16.

IMPROVEMENT OF SWANTON HARBOR, VERMONT.

During the past fiscal year the work of extending the breakwater under the appropriation of \$4,500, made by the act of August 2, 1882, was advertised, but there being no bids received, it was recommended by the officer in charge, and approved by the Department, that the work be done by hired labor and purchase of material in open market. Under this authority the filling with stone of the crib sunk during 1881 was completed, and work was in progress upon the building of an additional crib, to be placed in extension of the breakwater, and the construction of 78 linear feet of superstructure over the crib sunk in 1881.

During the present season it is proposed to complete and place one crib substructure 50 feet in length in extension of the breakwater and complete the superstructure over 78 linear feet of breakwater.

When the site of the breakwater was selected it was supposed that the docks and wharves would be located in its vicinity. But in 1877 the docks were located about three-fourths of a mile north of the breakwater then in process of construction, thus rendering doubtful the protection which the breakwater was proposed to furnish. The Saint Johnsbury and Lake Champlain Railroad Company have recently brought their line to this harbor, and are considering the site of docks and wharves for the same.

In view of the inadequate protection afforded to the present docks and wharves, and the uncertainty of the location of the new ones, it is advisable to defer further extension of the breakwater until the action of the railroad company shall have given indications of requirements for further breakwater extension.

Money statement.

July 1, 1882, amount available	\$1, 909 06
Amount appropriated by act passed August 2, 1882.....	4, 500 00
	<hr/>
	6, 409 06
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	1, 764 24
	<hr/>
July 1, 1883, amount available.....	4, 644 82
	<hr/>
Amount (estimated) required for completion of existing project.....	170, 000 00

COMMERCIAL STATISTICS.

The following statement of the commerce of the port of Swanton, Vt., for the fiscal year ending June 30, 1883, is, through the courtesy of the collector of customs, furnished from the records of the custom-house:

Revenue from customs	\$1, 063 70
Value of imports	\$10, 537 00
Number of vessels cleared	13
Their tonnage	474
Number of vessels entered.....	13
Their tonnage	474

Chief articles of commerce: Iron and coal.

M M 17.

IMPROVEMENT OF BURLINGTON HARBOR, VERMONT.

During the past fiscal year one crib substructure, 50 feet in length, was built and placed in the northerly extension of the breakwater. Under a contract with Dellabach and Murphy, dated May 13, 1882, a part of the stone required for crib filling was furnished, but failing to complete their contract the balance was purchased in open market. Under an advertisement for proposals dated November 14, 1882, for the extension of the breakwater, no bids were received, and upon the recommendation of the officer in charge, and with the approval of the Chief of Engineers, the work of building and placing one crib 50 feet in length and building superstructure over 109 linear feet of breakwater was undertaken by hired labor and purchase of material in open market. At the close of the fiscal year the crib was ready for sinking and the timber and iron on hand for the proposed superstructure. During the present season the foregoing work will be completed.

A survey of the harbor was made in November and December, 1882, and the results of the survey seem to indicate that the wharves and shipping would be better protected by an extension of the breakwater southward and inclining toward the shore.

The superstructure of about 1,000 linear feet of the breakwater immediately south of the light-keeper's house is very much decayed, and will require repairing at an early date.

Continuation of the breakwater with necessary repairs is the work contemplated during fiscal year ending June 30, 1885.

Money statement.

July 1, 1882, amount available.....	\$2,803 26
Amount appropriated by act passed August 2, 1882.....	12,000 00
	<hr/>
	14,803 26
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	8,661 75
	<hr/>
July 1, 1883, amount available.....	6,141 51
	<hr/>
Amount (estimated) required for completion of existing project	228,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	50,000 00

COMMERCIAL STATISTICS.

The following statement of the commerce of the port of Burlington, Vt., for the fiscal year ending June 30, 1883, is, through the courtesy of the collector of customs, furnished from the records of the custom-house:

Revenue from customs	\$207,487
Value of imports	\$1,347,149
Number of vessels cleared	540
Their tonnage	81,000
Number of vessels entered	540
Their tonnage	81,000
Probable number of arrivals and departures of vessels which do not enter or clear	1,600

Chief articles of commerce: Lumber, coal, salt, iron.

During the past fiscal year, under a contract with L. Whitney, dated September 10, 1881, 10,791 cubic yards were dredged from Vergennes Basin, Bullbrook, Smith's, and Gage's bends. Under the project for the expenditure of the appropriation of August 2, 1882, proposals were invited for work at Bullbrook Bend. No bids were received, and with the approval of the Chief of Engineers the work at this point is to be done by hired labor. The dredging done during the season of 1881 and 1882 developed the existence of rock at several points requiring increased depth. The original project did not provide for any rock removal. A detailed examination will be made during the present season to fully develop the extent of the obstructing ledges, and the results of such examination will determine the work, if any, to be done this season.

The deepening and widening of the channel is the work contemplated during the fiscal year ending June 30, 1885.

Money statement.

July 1, 1882, amount available.....	\$5, 780 34
Amount appropriated by act passed August 2, 1882.....	2, 000 00
	7, 780 34
July 1, 1883, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1882.....	3, 744 37
	4, 035 97
Amount (estimated) required for completion of existing project.....	39, 748 40
Amount that can be profitably expended in fiscal year ending June 30, 1885.	20. 000 00

M M 19.

IMPROVEMENT OF TICONDEROGA RIVER, NEW YORK.

During the past fiscal year, 14,981 cubic yards were removed under an agreement with Luther Whitney, at the rate of 20 cents per cubic yard.

An examination made in July, 1883, showed that the channel had fairly maintained a depth of 6 feet at low water. The high stage of Lake Champlain during the season has rendered the present depth of channel in Ticonderoga River deep enough for the demands of this season, and parties most interested in the improvement preferred that the small unexpended balance be held in reserve to do such dredging as might be necessary early next season. The improvement proposed by the present project is to meet the requirements of a commerce based upon the transportation annually of about 8,000 cords of wood and 2,000 tons of coal. Continuation of dredging is contemplated during the fiscal year ending June 30, 1885.

Money statement.

Amount appropriated by act passed August 2, 1882.....	\$5, 000 00
July 1, 1883, amount expended during fiscal year.....	3, 485 80
	1, 514 20
Amount (estimated) required for completion of existing project.....	32, 516 00
Amount that can be profitably expended in fiscal year ending June 30, 1885.	10, 000 00

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